TECHNOLOGY DEPT.

Gas Journal

VOL. 288. 108th YEAR. LONDON, DECEMBER 12, 1956. No. 4874. PRICE 1/6

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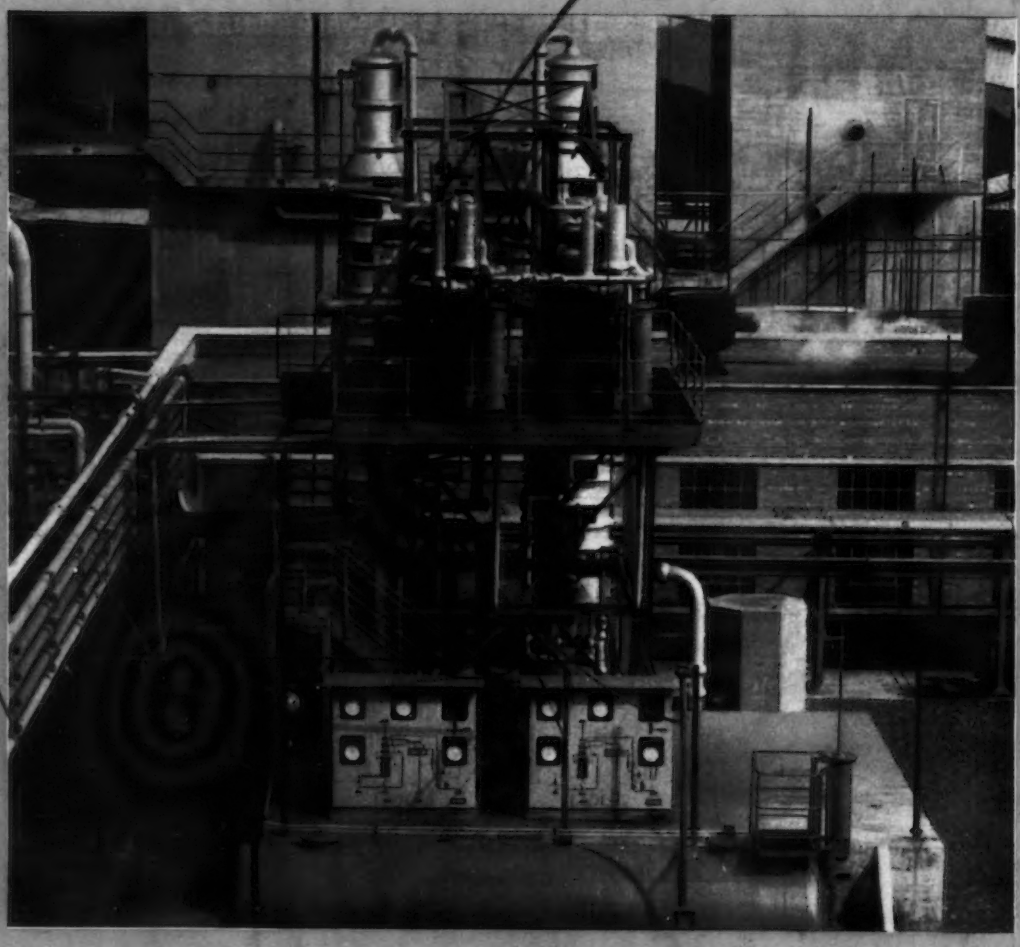
JAN 11 1957
DETROIT

Liquor Concentration Plant



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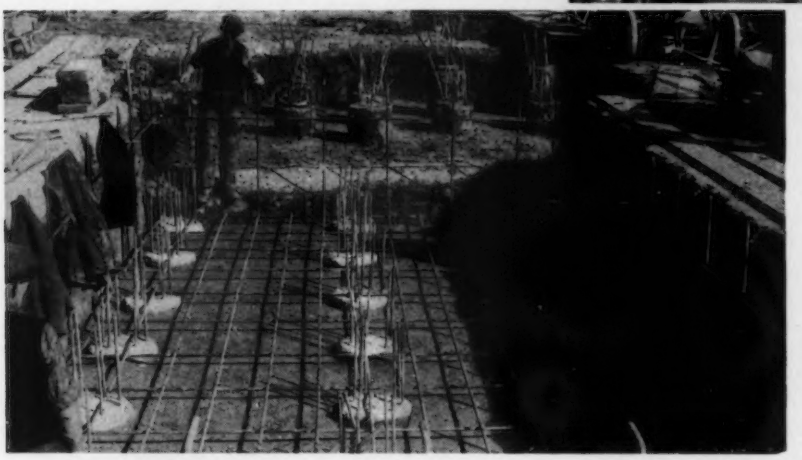
by HOLMES

W. C. HOLMES & CO. LTD · TURNBRIDGE · HUDDERSFIELD

C 8521

BORED PILES FOR THE N.F.U. KNIGHTSBRIDGE SITE



The heavy foundation loading from this building made normal footings for the columns out of the question—a condition frequently obtaining to-day when higher storeys are permitted. Piling was necessary and the close proximity of other buildings, including a Hospital, precluded the use of heavy driving equipment with its accompanying noise and vibration.

Cementation Bored Piles were selected by competitive tender and the foundation work was completed very successfully notwithstanding the difficult ground conditions unexpectedly encountered.

The CEMENTATION COMPANY LIMITED

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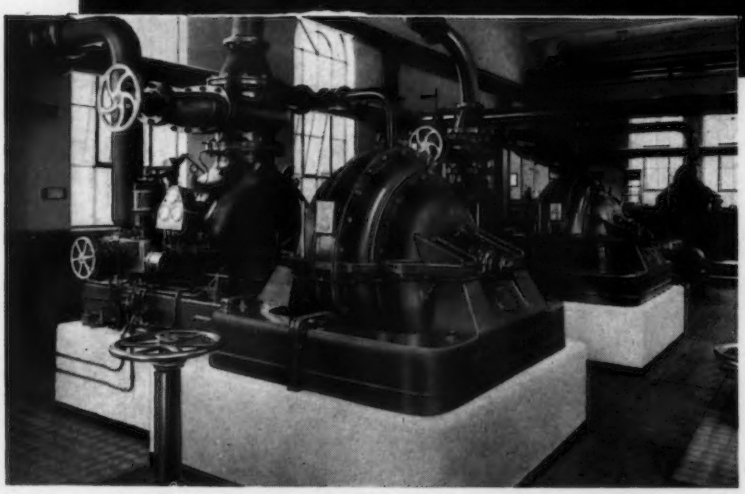
Tel.: DON. 54177-8-9
LONDON OFFICE: 20, ALBERT EMBANKMENT, S.E.11.
Tel.: RELiance 7654

'C.M.' TYPE TURBO BOOSTERS
for medium volumes and higher pressures



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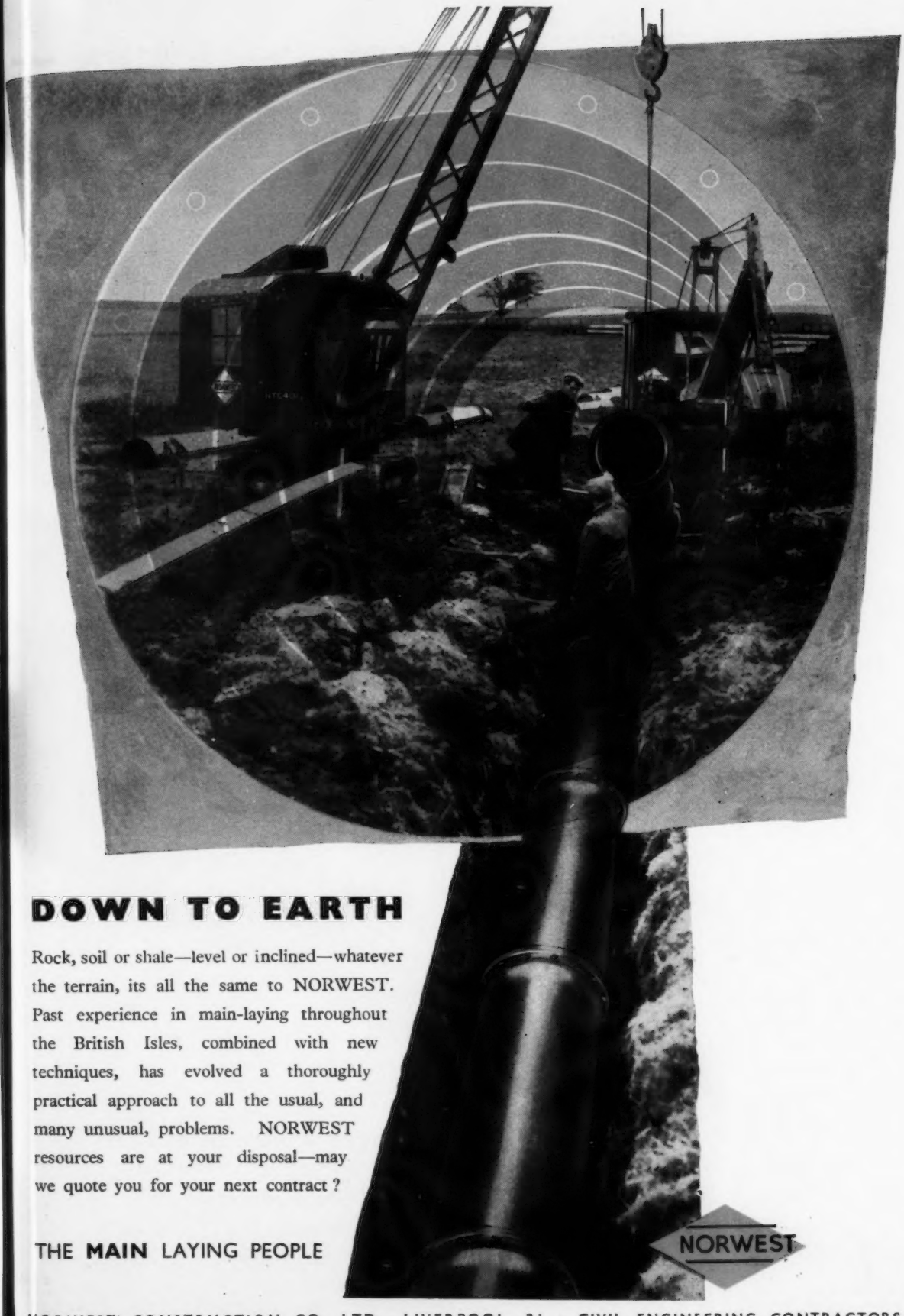
'CM' 62 Two Stage Turbo Boosters each to pass 500,000 cubic feet per hour at 5 lbs per square inch (Gas—specific gravity = .55) Driven by 260 b.h.p. Brotherhood Turbines running at 7,000 r.p.m.

Installed at Waddon Works, Croydon, for the supply of gas to:— Redhill, Horley, and Crawley New Town.

THE BRYAN DONKIN CO. LTD.
DERBY ROAD · CHESTERFIELD



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Rock, soil or shale—level or inclined—whatever the terrain, its all the same to NORWEST. Past experience in main-laying throughout the British Isles, combined with new techniques, has evolved a thoroughly practical approach to all the usual, and many unusual, problems. NORWEST resources are at your disposal—may we quote you for your next contract?

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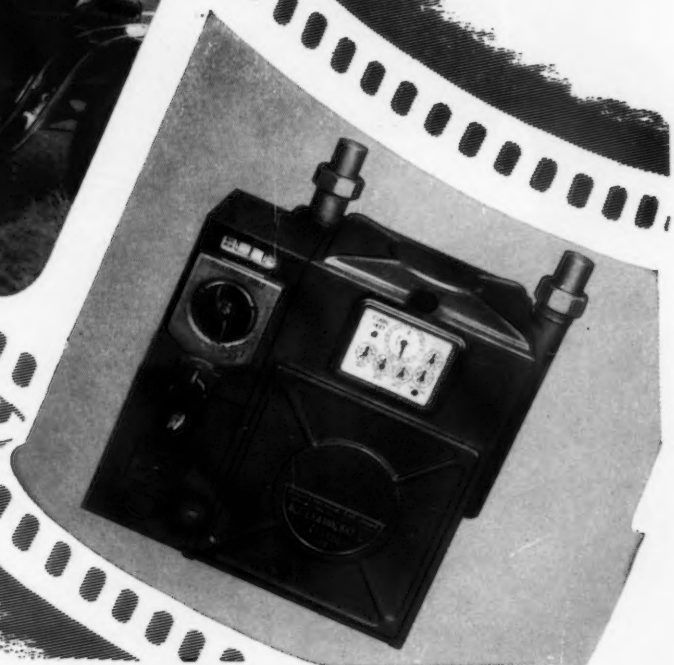
GENEVIEVE, the 1904 Darracq from the hilarious J. Arthur Rank film, aptly expressed in its nerve-tingling Brighton to London run, an invaluable asset of A. & M. Meters . . .

Photo by courtesy of the J. Arthur Rank Organisation.

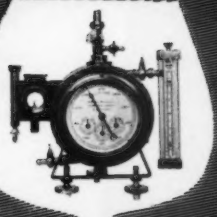


It's trouble-free running that does it!

Trouble-free running is indeed an outstanding feature of the current series A. & M. Meters with the "S" Mechanism. Sound design, robust construction, precise assembly and rigid inspection all add up to a new standard of trouble-free operation.

The illustration shows the A. & M. D.1/200 c.ft. "S" type coin meter for 1/- only—simpler and less expensive than the optional which is also available.

LABORATORY METERS
1/50th to 5 c.ft per rev., accurate to 0·1%±



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GAS METER & INSTRUMENT MAKERS

NEW GRANGE WORKS, EDINBURGH, 11, and at London and Manchester.

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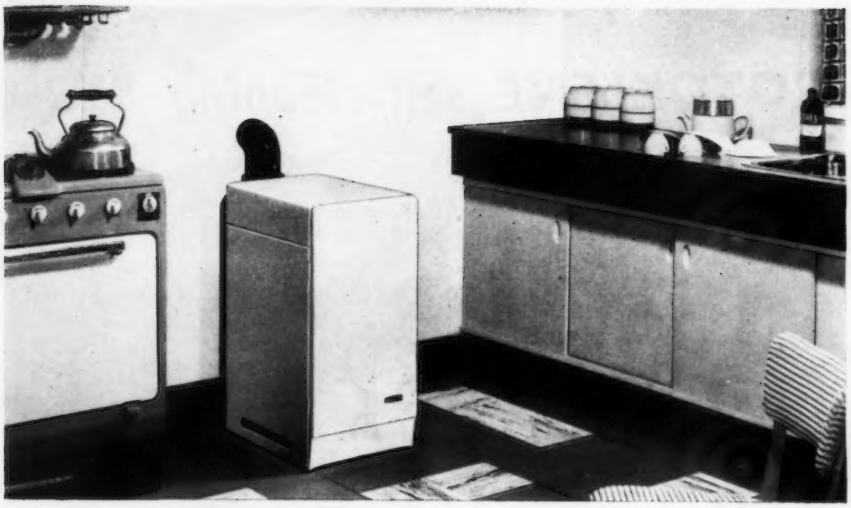
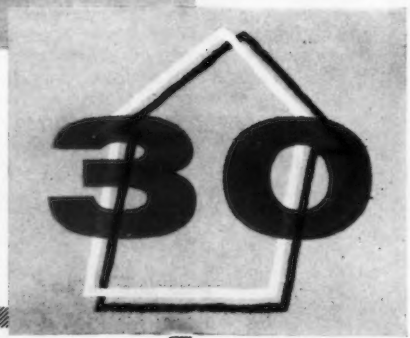


"Just sits in the corner of the kitchen and minds its own business"

Those are the words that an owner recently used when speaking of his 'Diplomat' Gas-Fired Boiler. They are, in fact, quite an accurate description, for the 'Diplomat' is entirely automatic and requires a minimum of maintenance.

The 'Diplomat' is one of the latest additions to the famous 'Potterton' family. It is built to give unfaltering service for years and years—and at the same time it is simply yet attractively designed and sells at a competitive price. Men like it because, once it is installed, they can forget all about it; women like it because, with its choice of colours it fits into any kitchen scheme—and is so easy to clean.

It is at present available in two sizes; other models are being developed. Special 'glass'-lined waterways by a new process can be supplied for soft-water areas. Easy accessibility, foolproof controls and the fact that on first lighting from cold there is virtually no condensation mean that the 'Diplomat' can always be recommended with complete confidence.



The 'Diplomat' Gas-Fired Boiler

A MODEL OF SELF-CONTROL

Available in white · cream scarlet and viridian green

Cost of living
Provided no major factors intervene, the price of De La Rue products will be stabilized until March 31st, 1957.

THE DIPLOMAT GAS-FIRED BOILER

	Max. Gas Rate B.t.u./hr.	Max. Heat Output B.t.u./hr.
DIPLOMAT 30	40,000	30,000
DIPLOMAT 44	55,000	44,000

	Height	Width	Depth
DIPLOMAT 30	32½"	15"	27"
DIPLOMAT 44	32½"	15"	27"

POTTERTON GAS FIRED BOILERS DE LA RUE

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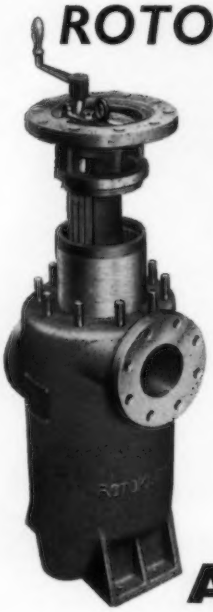
DLR 594

ROTOKLENE self-cleaning STRAINERS



This self-cleaning strainer has many unique features which may be valuable in your business. It is widely employed on fuel and lubricating oil systems, water, soap, paint, tar, chemicals and many other liquids and has proved its efficiency over a long period.

- *Unique cleaning method — extremely simple and reliable.*
- *Can be belt or motor driven where constant cleaning is necessary.*

May we send you details of its novel and extremely effective principle of working?

The **ROTOKLENE'S** special vee-section wire winding offering minimum resistance to flow and instantly cleaned.

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GASHOLDERS

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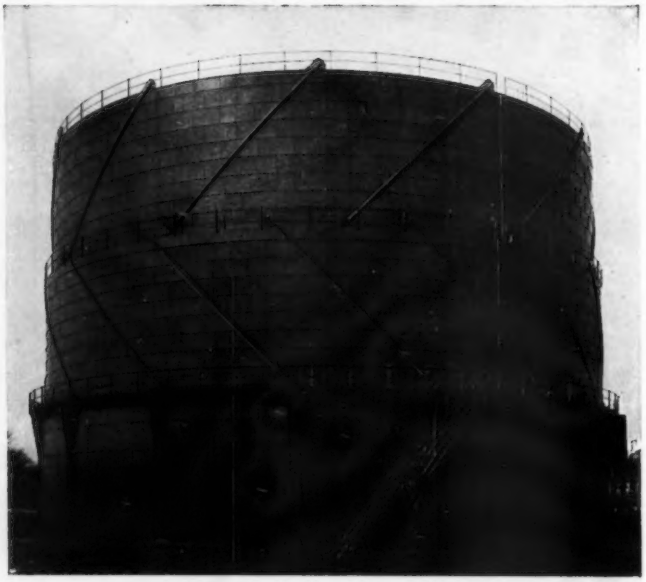

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NEW MAIN MAY BE FUTURE BURIED GAS HOLDER

Lincoln Diesel Welders & Fleetweld 5* Electrodes used exclusively

The contractors—William Press & Son Ltd., laying a section of the 18" main across the Rye, High Wycombe. This is the first Gas main built in Great Britain with a test pressure of 400 lb. per square inch.

Rapidly nearing completion is the laying of a new 18 in. main just four miles long, running from Wooburn to High Wycombe gas works in Buckinghamshire. This stretch of main, when it comes into operation, will be a landmark in the history of the North Thames Gas Board, for it will then mean that every one of the Board's manufacturing stations will be connected up directly on the Board's grid system.

It is more than just another new main. It embodies many new and interesting features being the first gas main to be built in Great Britain with a test pressure of 400 lb. per square inch. The main has been designed for possible gas storage, and when a compressor is fitted later, it will be capable of storing 730,000 cu. ft. of gas—virtually an underground gas holder. Working pressure when the main is used for storage will not exceed 260 lb. per square inch.

Designed and planned by the Board's Distribution Department, this welded steel pipeline has seen some new and important ideas in main-laying, ideas which have aroused great interest in the industry.

Many modern techniques were adopted, one of which was the method of stovepipe 'down-hand' welding. This resulted in a greater speed in carrying out the job. Welding of the sections was carried out while they were supported over the trench, and the weld, being as strong as the pipe and possessing the same degree of flexibility, allowed the main to be lowered into the trench almost as soon as the welders had passed along to the next section.

Contractors for laying this main were William Press and Son Ltd.

Gamma-ray Inspection by M.A.P.E.L. Ltd.

* FLEETWELD 5 conforms to B.S.S.639 Class A. It is approved by the Admiralty, Lloyd's Register of Shipping, British Corporation Register of Shipping and Aircraft, Board of Trade and Ministry of Supply, the Aeronautical Inspection Directorate and for Admiralty 'D' quality steel in all positions.

● [TOP] *Positioning and tack welding a bend prior to welding. All joints were tested radiographically by Gamma-ray.*

● *Downhand welding. Lincoln Fleetweld 5 Electrodes and Diesel welders were used exclusively on this new gas main.*

BRITISH FLEETWELD 5

Largest manufacturers of D.C. Welders in the United Kingdom

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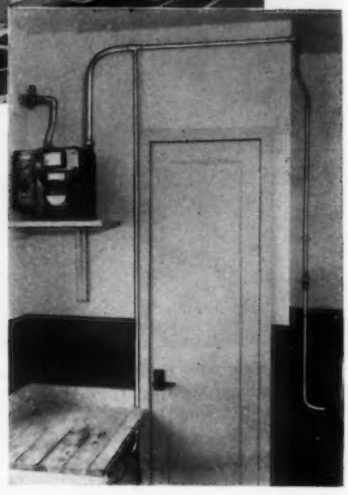


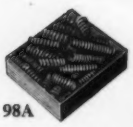
are used for the gas carcassing in the "Miller" Houses, Burgh of Barrhead.

Plumbing Contractors: Robert Rome & Son, Limited, Rutherglen

Meter Connections by Scottish Gas Board, Barrhead District

THE YORKSHIRE COPPER WORKS LTD. · LEEDS & BARRHEAD

No. 760


No. 98A

No. 757

No. 388.

No. 758.

No. 466.

No. 1013.

No. 753.

No. 1024.

No. 760. 3 doz. Assorted Light Compression Springs ½" to 4" long, 22 to 18 S.W.G., ¼" to ½" diam. 6/6. **No. 98A.** 3 doz. Assorted 1" to 4" long, ¼" to ½" diam., 19G to 15G. 5/6. **No. 757.** Extra Light Compression, 1 gross Assorted, ½" to ½", ¼" to 2" long, 27 to 20 S.W.G. 15/-. **No. 388.** ½ gross Assorted Small Expansion Springs, ½" to 1½", 18G to 21G. 9/6. **No. 758.** Fine Expansion Springs. 1 gross Assorted ½" to ½", ¼" to 2" long, 27 to 20 S.W.G. 15/-. **No. 466.** ½ gross Assorted Small Expansion Springs ½" to 1½" long, 3/32" to 3/16" diam., 21G to 24G, 6/6. **No. 1013.** 1 gross Small Coil Compression Springs, ½" to 1½" long, 3/32" to 7/16" diam., 24G to 19G 6/-. **No. 753.** 3 doz. Assorted Light Expansion ½" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. 10/6. **No. 1024.** 20 Compression Springs 12" long, ½" to ½" diam., 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansions 1½" to 12" long, 5/32" to ½" diam., 22G to 16G. 24/-.

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TERRY'S BOXES OF ASSORTED SPRINGS are just the job for your experimental department—a wonderful assortment of Compression and Expansion Springs... all sorts of lengths, gauges, diameters. The nine boxes we show are just a few from our range. Why not let us send you a full list—free?

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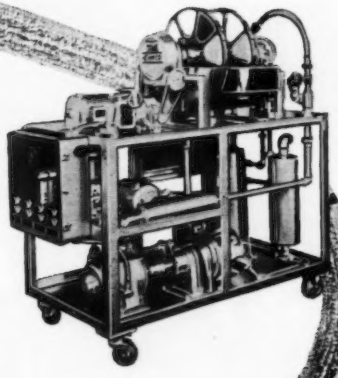
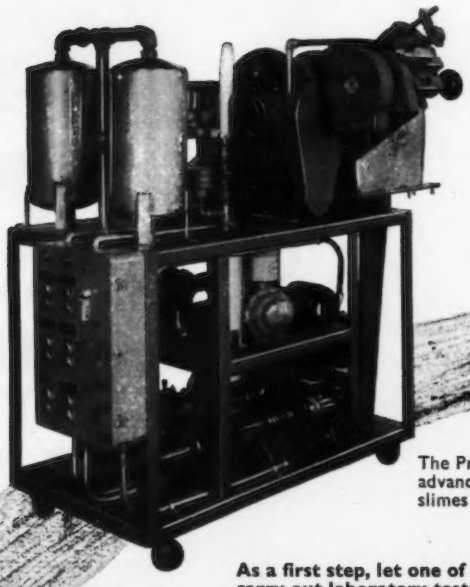
for "on the spot tests"

Eimco pilot plant filters, complete with all ancillaries, make it possible to take the plant to the sample, avoiding the possibility of change in the sample during transit, allowing extensive large-scale tests and giving accurate data to establish the optimum plant size and operating conditions.

The Rotary Vacuum Drum Filter can be arranged for either single or double solution operation, top or bottom feed, and scraper, string, roller or snap-blow discharge.



The Disc Filter, affording greater filter area per square foot of floor space, is particularly useful where no cake washing is required.



The Precoat Drum Filter is arranged with an automatic knife advance mechanism for shaving the precoat, thus removing slimes as they are deposited and allowing free filtration.

As a first step, let one of our engineers visit you and carry out laboratory tests with portable equipment.

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FOR THE GAS INDUSTRY
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Moisture ... ... 38% (loss on heating at 212 F)
63%-65% (Total iron calculated as Fe2O3,3H2O on the dry basis)
Ferric Hydrate
The following allowances will be made in the case of any deviation from the above specification:—
For each complete 1% Moisture in excess of 38% 6d. per ton allowance.
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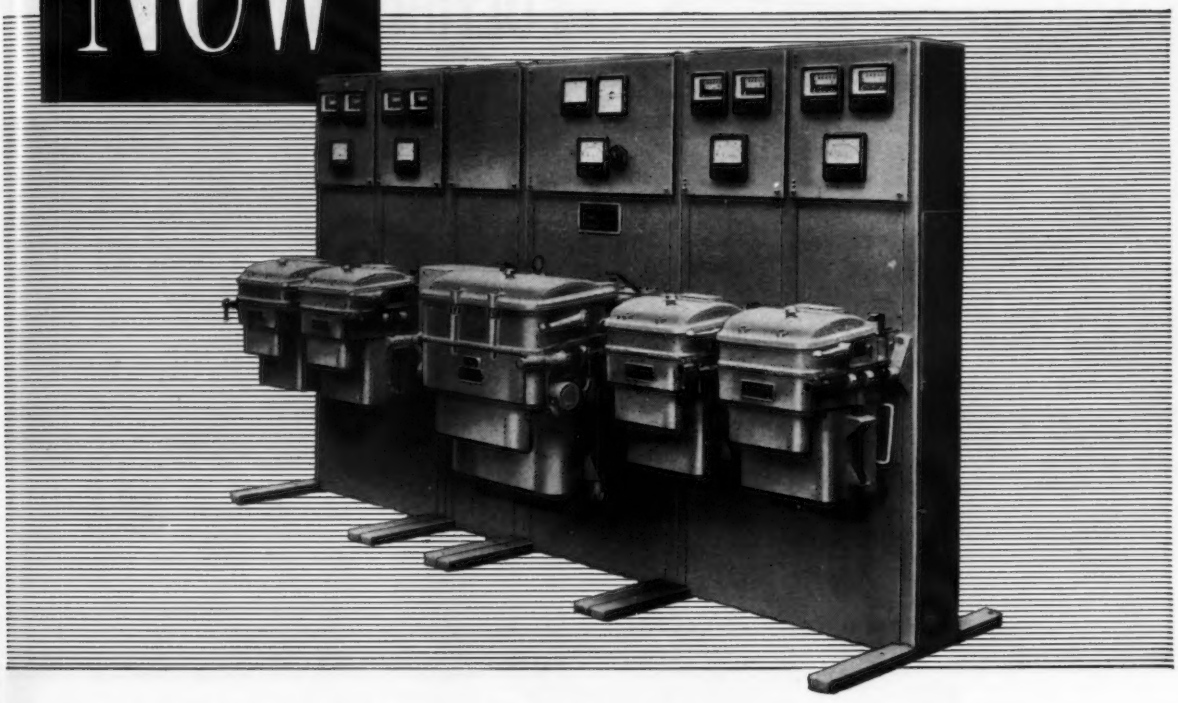
Grams. "OXIDE" MANCHESTER

New *and craftsman built . . .*



ELLISON GEO switchgear

* High technical excellence at industrial prices.
* Robustly constructed for many years of dependable service.
* Designed for easy maintenance.

Planned and produced in the Ellison tradition, this new GEO range of electric switchgear upholds, in every way, the Company's reputation for reliable pedigree products. Circuit breakers have reversible main and arcing contacts, solenoid-operated, series-wound release coils with time lags and free handle on overcurrent. Auxiliary switches can be fitted on site. For further information please ask for Leaflet C.L.244.

CIRCUIT BREAKERS Horizontally isolated, draw-out type for service voltages of up to 660.	
CURRENT RATING	**OVERALL WIDTH**
400 amp. 600 amp. 800 amp. 1,200 amp.	20 inches 24½ inches 25½ inches 28½ inches

BREAKING CAPACITIES		
Size	Breaking Capacity at 600 volts	Breaking Capacity at 400 volts
400 amps. 600 amps. 800 amps. 1,200 amps.	37·5 MVA 45 MVA 45 MVA 45 MVA	25 MVA 30 MVA 30 MVA 30 MVA

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A.S.T.A. TESTED TO BS. 116:1952

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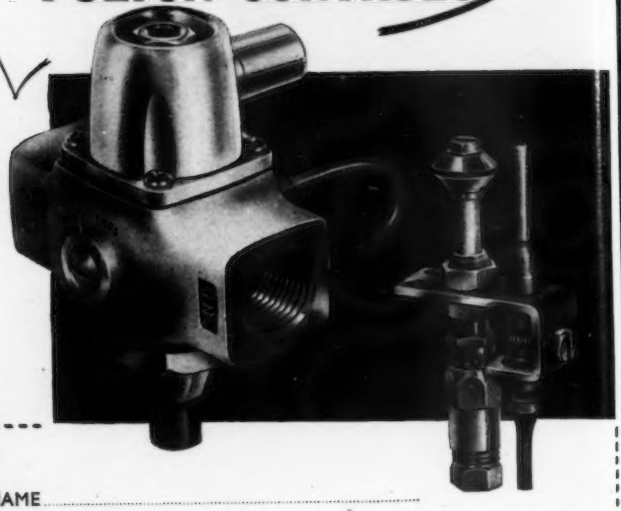
... combined to produce this PRECISION SHUT-OFF VALVE

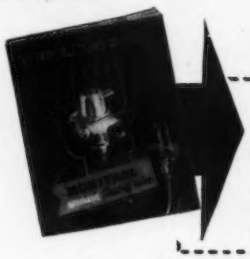
and U.S.A'S ROBERTSHAW-FULTON CONTROLS

When two great engineering companies combine to produce a vital piece of equipment, you can be sure that the result will be acclaimed by experts everywhere. And it is a fact that progressive gas engineers almost automatically specify the Monitrol Automatic Shut-Off Valve. Its advanced design, precision manufacture and absolute reliability have ensured its final approval and acceptance in the most exclusive engineering circles.

- ★ **High precision components instrument assembly techniques employed.**
- ★ **Magnet surfaces ground to flatness limits never before achieved in quantity production.**
- ★ **Manufactured throughout in an air-conditioned factory.**



MONITROL AUTOMATIC *Shut off* VALVE



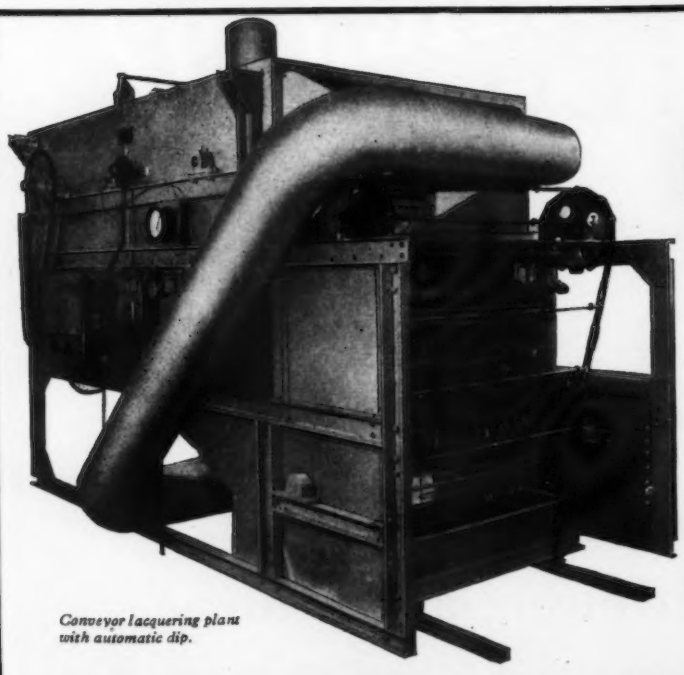
Send the coupon for this informative, fully-illustrated booklet which describes the construction, operation and installation of the Monitrol Valve Thermo-Couple and Pilot Burner.

A Member of the Parkinson & Cowan Group.

NAME .....

ADDRESS ..... G.J.

MONITOR ENGINEERING & OIL APPLIANCES LTD., STECHFORD, BIRMINGHAM, 33



Conveyor lacquering plant with automatic dip.

INDUSTRIAL DRYING OVENS FOR ALL PURPOSES

ENAMELLING OVENS

AND

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ALSO MANUFACTURERS OF STEEL PLATE GAS MAINS AND FABRICATED STEEL STRUCTURES FOR THE GAS INDUSTRY

SILAS HYDE LTD.

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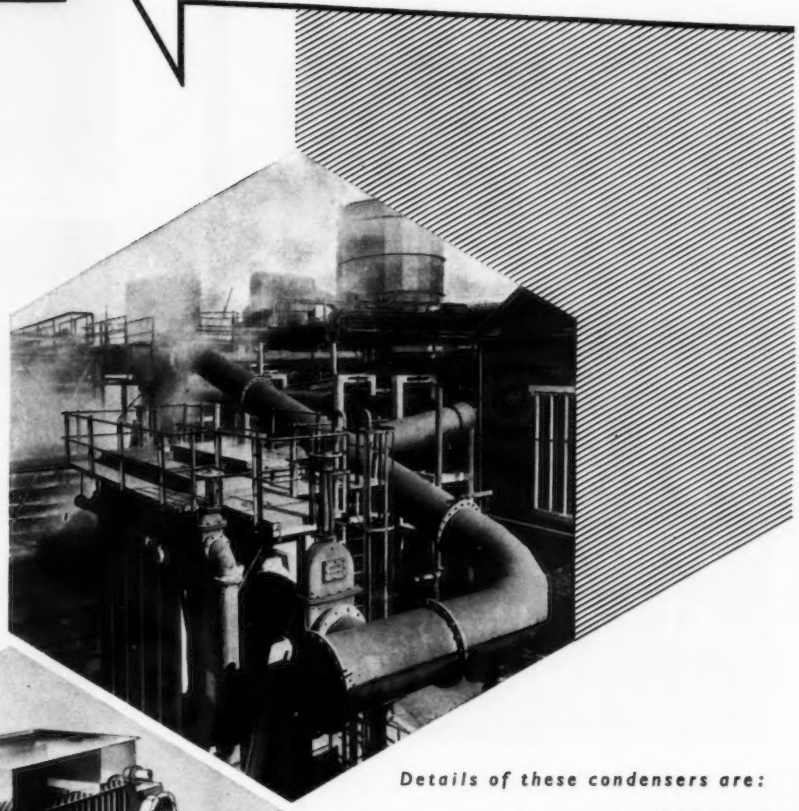
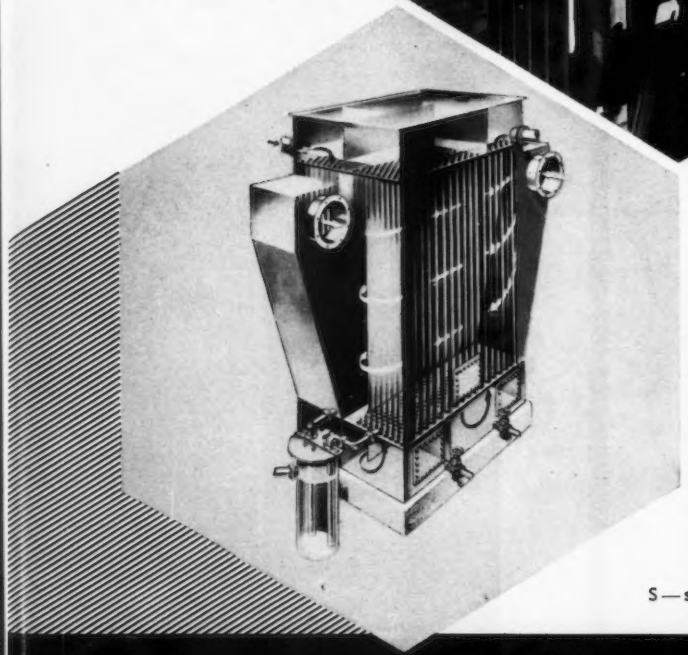
WHESSOE

CROSS FLOW CONDENSERS

Since the introduction of this extremely efficient gas cooling unit 20 have been placed on order and 13 of them are already in operation. The total capacity of these condensers is over 80,000,000 cu. ft. per day.





Details of these condensers are:

Customer and Location	No. Condensers	Total Capacity of Condensing Plant
Scottish G.B., Paisley	2 (P)	8 mill. cu. ft./day*
W. Midlands G.B., Redditch	2 (P)	3½ ,, ,, ,, *
Wales G.B., Aberavon	2 (S)	6½ ,, ,, ,, *
N. Western G.B., Linacre	2 (P)	8 ,, ,, ,, *
N. Western G.B., Bolton	2 (S)	8 ,, ,, ,,
Consett Iron Co., Consett	3 (P)	24 ,, ,, ,, †
S. Western G.B., Devonport	1	2½ ,, ,, ,, *
S. Eastern G.B., Gillingham	2 (S)	3 ,, ,, ,, *
E. Midlands G.B., Neepsend	2 (P)	5 ,, ,, ,,
Southern G.B., Oxford	2 (P)	12 ,, ,, ,,

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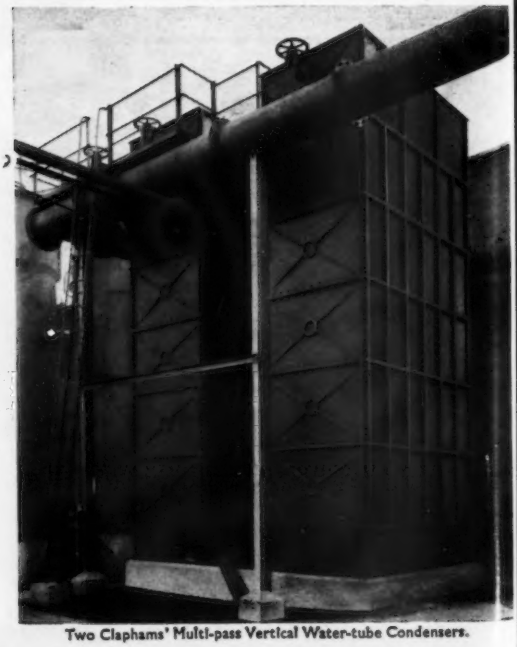

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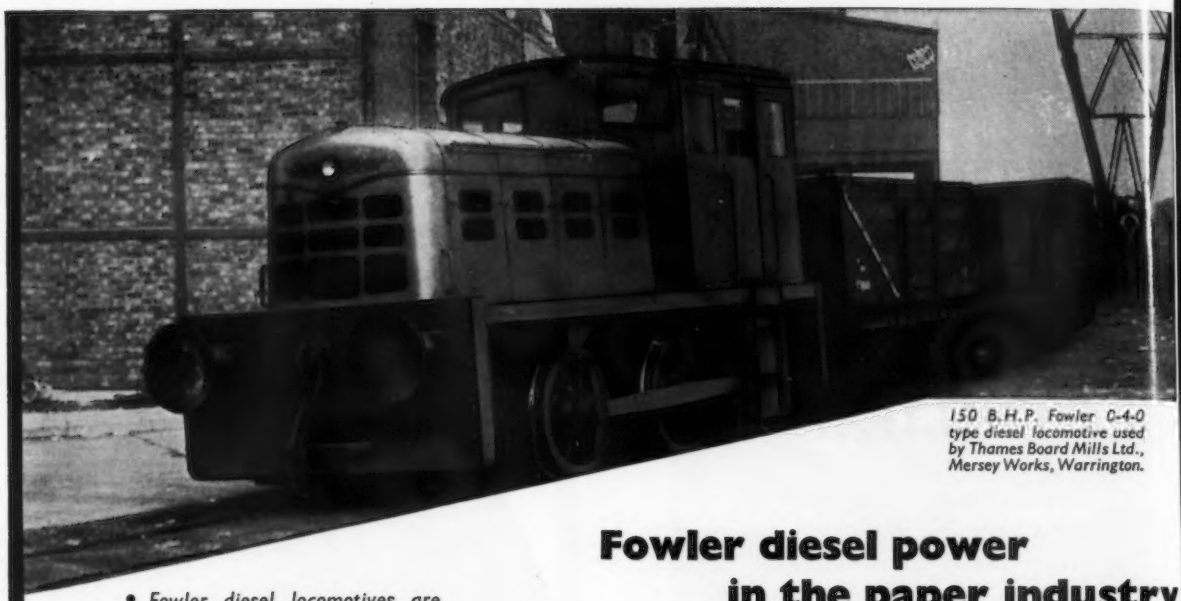

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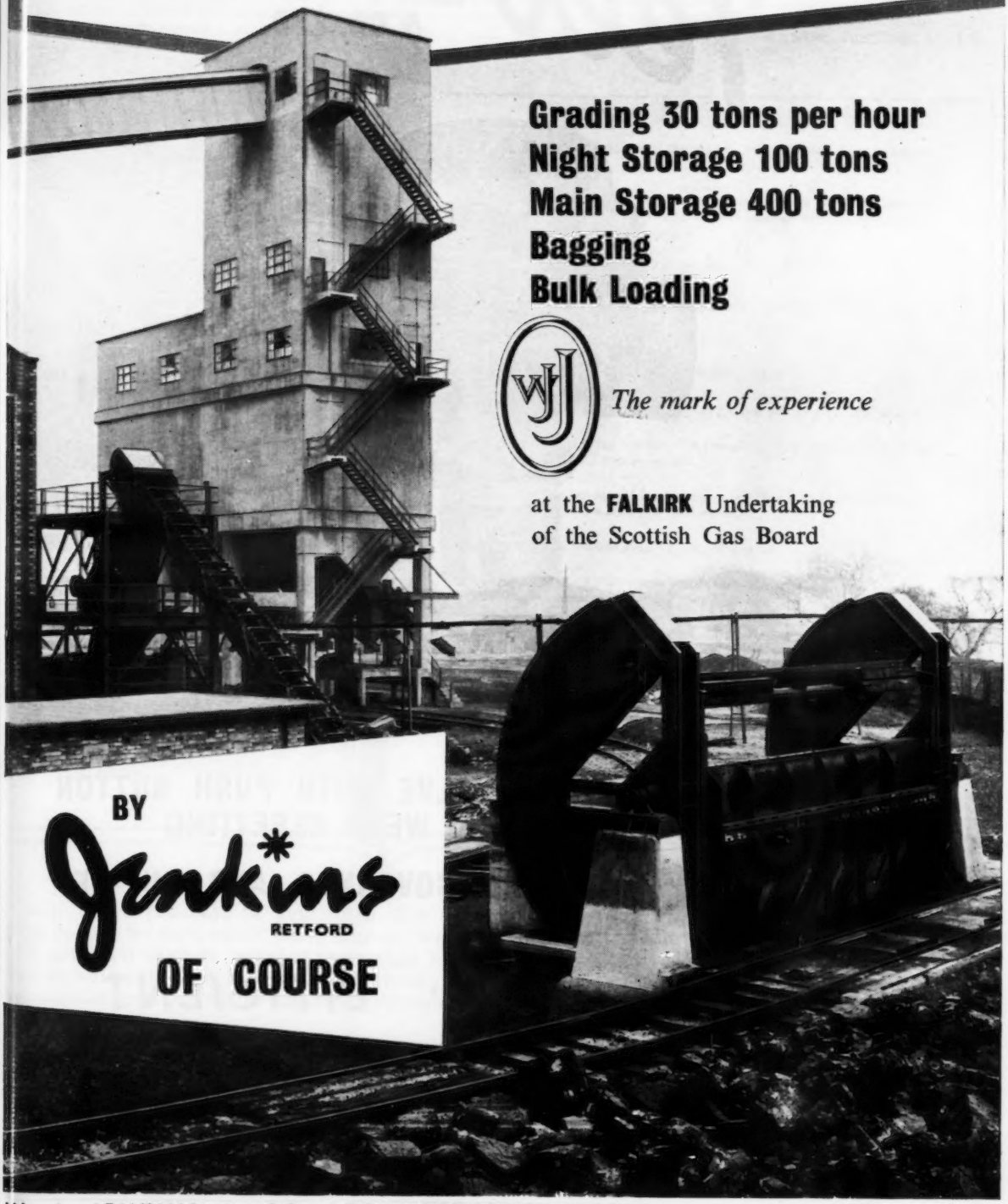

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FIG. 153 **GOVERNORS**

FIG. 154 **CUT-OFF VALVE WITH PUSH BUTTON CONTROLLED WEEP RESETTING**

FIG. 155 **COMBINED GOVERNOR AND CUT-OFF VALVE**

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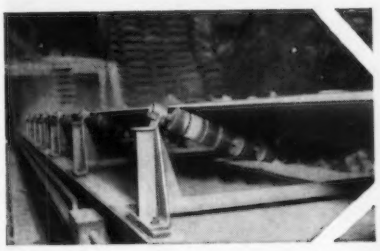

TYPE OF IDLERS : Limberollers. Designed by Joy in America. Built in Britain by Joy-Sullivan Ltd.

BASIC DESIGN DETAILS : Revolutionary design. Flexible steel cable covered in Neoprene and with Neoprene discs. Uses only two sealed-for-life bearings. (And they really are sealed-for-life).

NUMBER OF IDLERS INSTALLED : Ten.

PLACE OF INSTALLATION : South Bank—a constant trouble-spot.

DATE OF INSTALLATION : 5:3:56

DATE OF INSPECTION AND REPORT : 5:8:56

RATE OF WEAR : No wear as yet. Mould flashings still clearly visible on discs.

CARRYING QUALITIES : Excellent. Limberoller Idlers shape themselves to the load carried. Spillage reduced.

INSTALLATION DIFFICULTIES : None at all. They are far lighter and more easily installed, knocked down and moved.

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R. W. Johnson.

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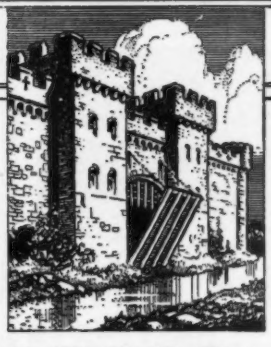

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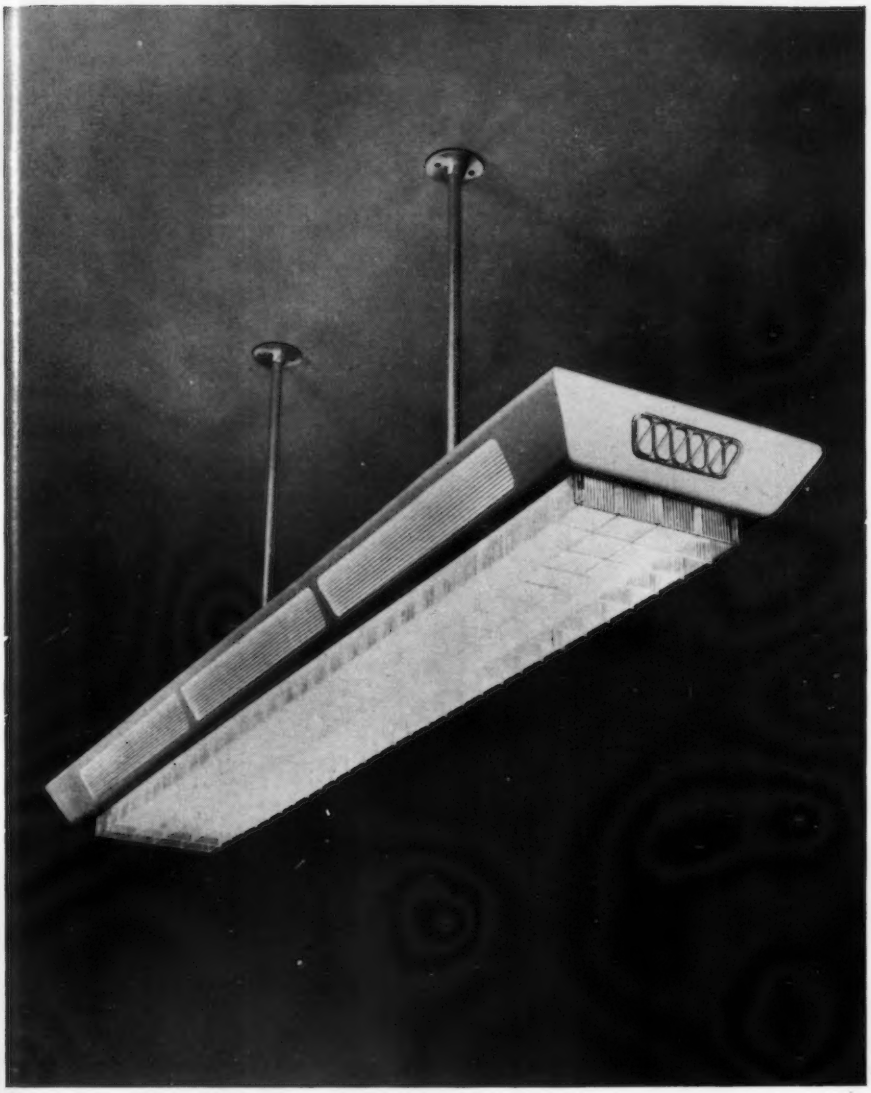

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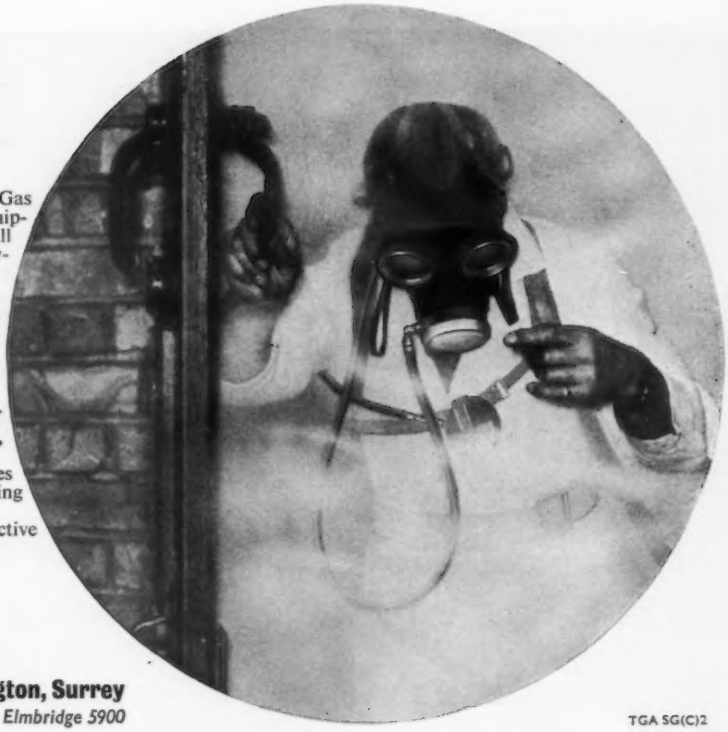

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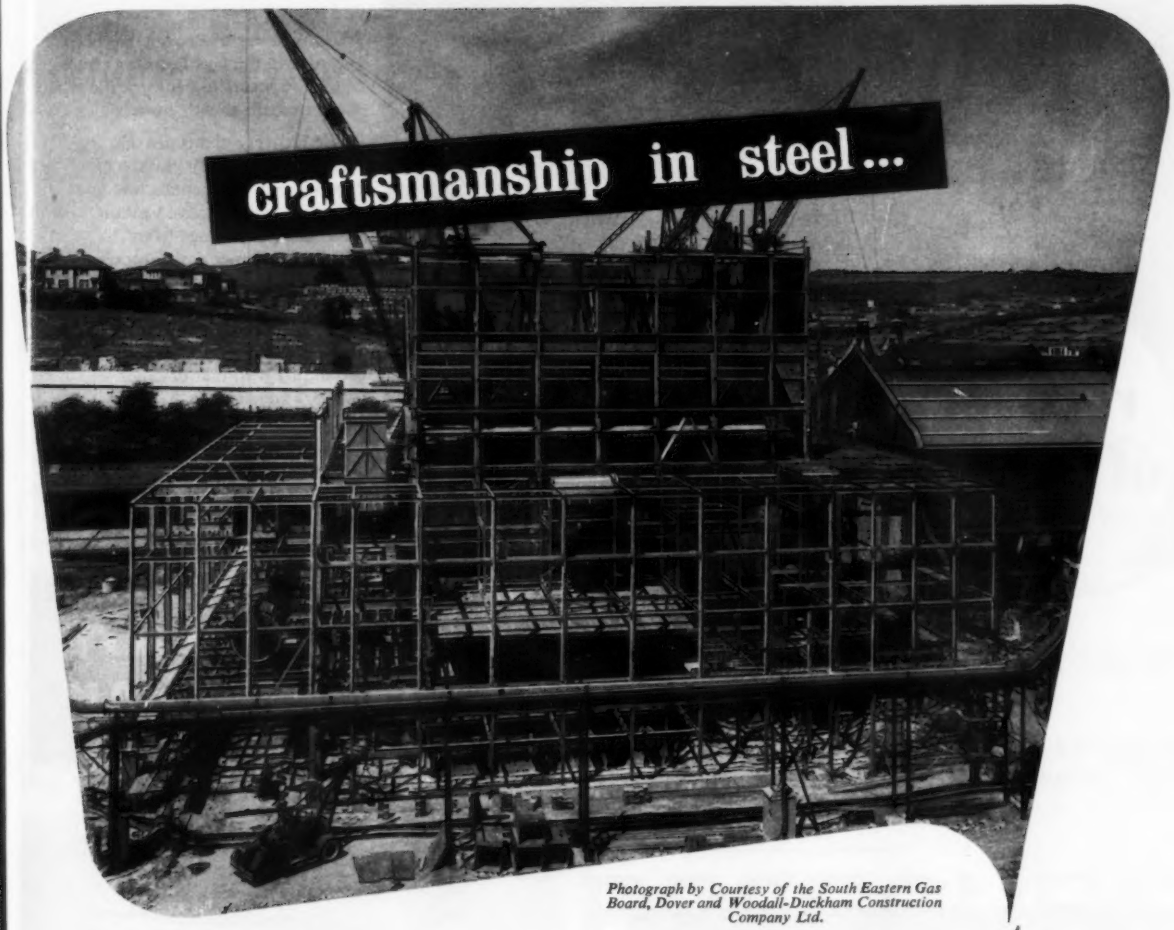

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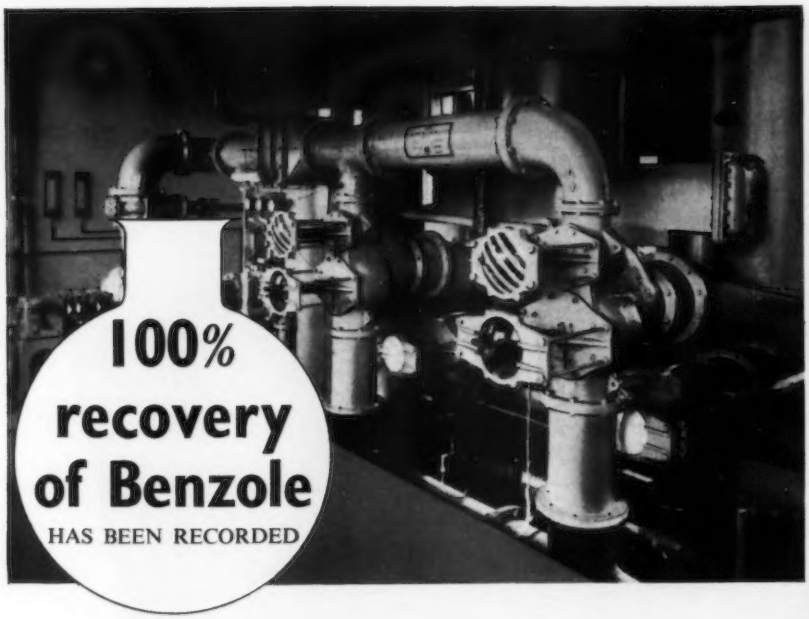

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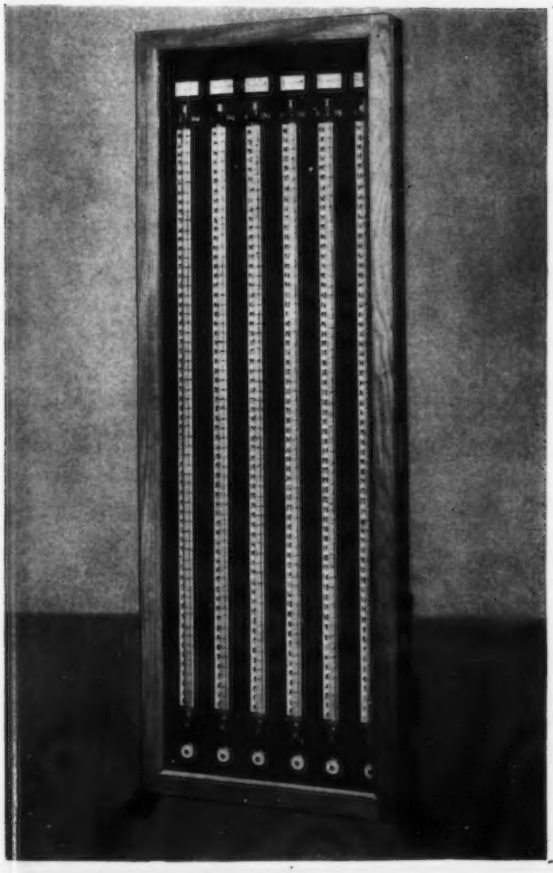

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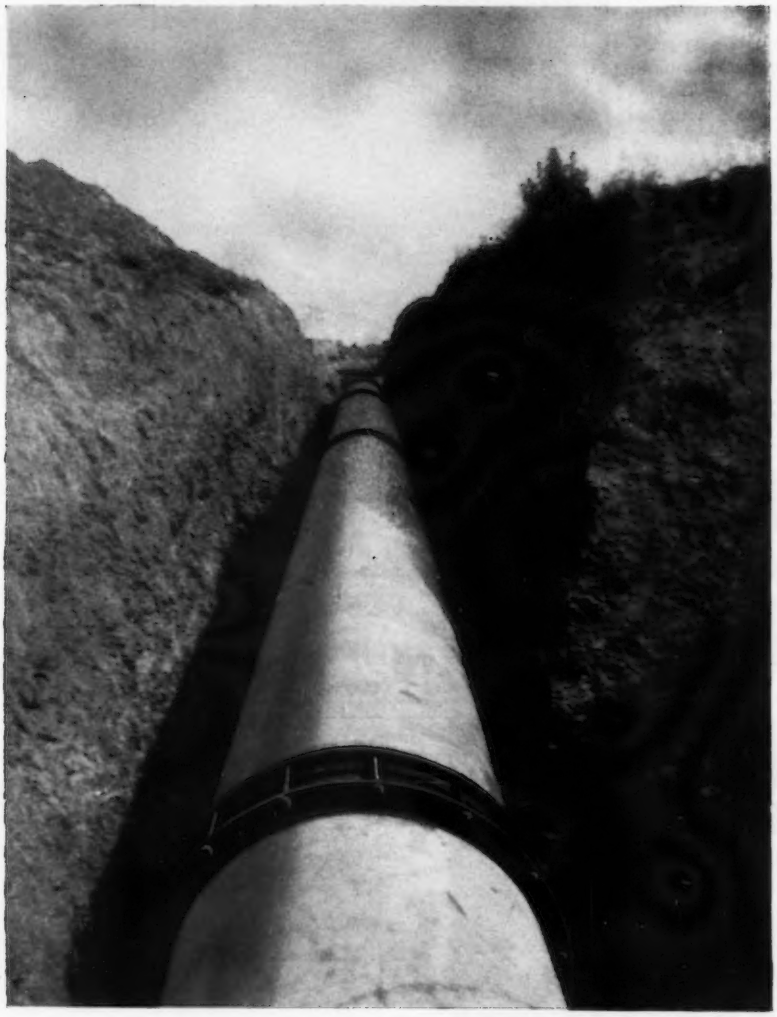

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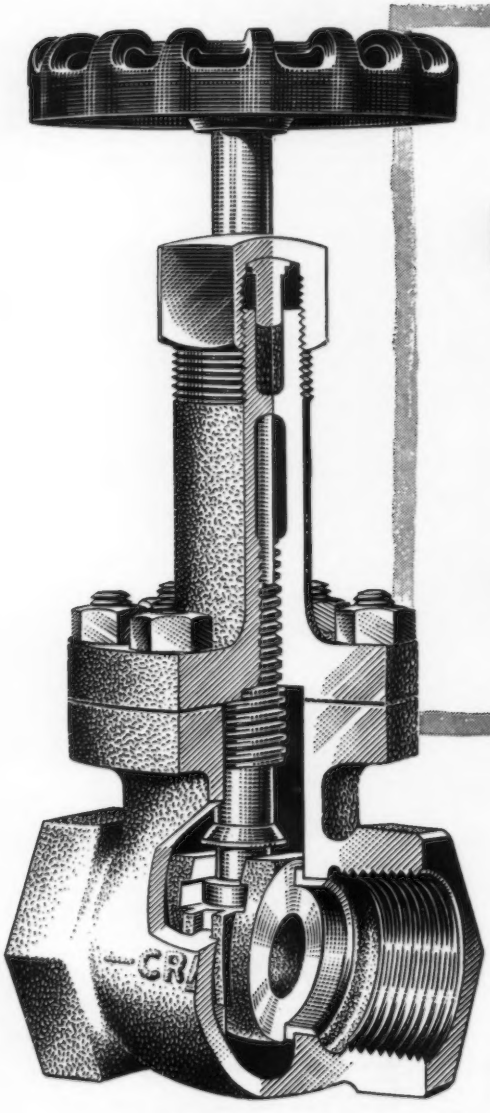

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Gas Journal

VOL. 288 *NO. 4874* *December 12, 1956*

108TH YEAR

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GAS METERS

1956

Gas Journal

VOLUME 288. No. 4874. DECEMBER 12, 1956. 108th YEAR

Predicting Satisfactory Service

THE importance of the many investigations which are being carried out with the object of predicting the performance of a gas when supplied to appliances on the district needs no emphasis in these columns. Our own appreciation on the significance of such researches is reflected in the space we devote in this issue of the 'GAS JOURNAL' to the interim report by Gilbert and Prigg on the work being undertaken at the London Research Station of the Gas Council. Before commenting on their paper, which was presented at the recent research meeting of the Institution of Gas Engineers, it may help to clarify the position if we briefly summarise its purport.

As all who are interested in the subject are well aware, the problem is by no means new. The gas industry has in its own interests always been very much concerned with giving satisfactory gas service while benefiting from the flexibility of the gas-making process. Today the problem is more complex because of the variety of raw materials which have become available and are being used for gas supply, among them oil, propane and butane, and methane. It is, as the authors point out, clearly desirable to be able to predict from simple analysis the likely performance of these newer gases individually and of town gas as distributed at different times of the year containing various proportions of these gases. Nor is the problem confined to this country. Stimulated by the availability of natural gas, Weaver in the U.S.A. and Delbourg in France have developed methods of prediction somewhat similar in principle to the method outlined by Gilbert and Prigg in their current report. However, the methods of Weaver and Delbourg, to which many references have been made in the 'JOURNAL,' relate to appliances and modes of test in their respective countries. Since performance must obviously be influenced by appliance design, any method of prediction applicable to Britain must relate to British appliances.

Thus, the object of the work at the London Research Centre, as set out in the report, has been to adapt conditions. This adaptation retains Delbourg's diagrammatic method of representing performance but uses Wobbe number and Weaver's calculated flame speed as axes of the prediction diagram, which is in fact the key point of the paper. On this fundamental diagram is defined an area of 'satisfactory' incomplete combustion. The limits for light-back and incomplete combustion are based on established practical tests for satisfactory performance. In the case of lift, however, it has been necessary to define a practical lift limit before placing this limit on the diagram. These limits depend on the gas used in the adjustment of the appliances and the method has been developed so that the limits can be drawn relative to any adjustment gas. Thus, if a proposed gas falls within the area bounded by the limits, it is assumed to be satisfactory and to be capable of replacing the normal town gas supply. If the gas falls outside the limits it will be unsatisfactory and the position on the diagram will indicate the type of unsatisfactory performance to be expected.

However, and this is important, such an unsatisfactory gas may still be used when mixed with another gas. The diagram does in fact show the types of gas that can be used for mixing, and from it can be derived the proportions which will give a satisfactory resultant gas for town supply. One type of unsatisfactory performance cannot be predicted from the diagram, and that is sooting on certain non-aerated appliances. As mentioned, the method involves the use of a calculated flame speed and the limits of the diagram have been drawn from empirical data. Hence the limits should be considered more as regions of doubtful performance than as clear-cut lines; hence, too, calculations from the diagram should be supplemented by experimental work. One of the outstanding advantages of the method, however, is that it enables this lengthy and costly experimental work to be kept as a minimum.

The triangular area defined by the limits of the diagram indicates to what lengths the gas industry can legitimately and safely go in mixing a variety of gaseous

constituents as best suits its book from season to season and even from day to day and in selling the mixture as town gas. It is to be hoped that the licence afforded by working within this triangle will not be unduly abused and that the apparent flexibility which the non-restricted area offers will not impose further demands on the ingenuity, patience and goodwill of the manufacturers of gas appliances. It is to be hoped that the approach to the use of this triangle by gas supplied will be one of restraint and caution.

The significance of our suggestion is, we think, indicated by the reference in the report by Gilbert and Prigg to the steps which were taken at Fulham to maintain gas supply during the cold weather of February, 1956. Benzene, which incidentally gives worse sooting than other hydrocarbons, happened to be readily available and was used as an additive to Fulham gas. By restricting the enrichment to 25 B.Th.U. per cu.ft. only the more sensitive gas fires showed signs of sooting on first lighting, which subsequently burnt off. Some sink water heaters produced puffs of soot on ignition, but no soot deposition was found in the heat exchangers of these heaters and no serious complaint of sooting on any appliance was received from the district. This indicates neither a wide margin of satisfactory appliance performance nor a really good case for unstinted congratulation. Moreover, there were times during this cold February spell when supply pressures in the North Thames Gas Board area were not beyond criticism, and no doubt other gas boards in the country experienced difficulty, though by and large the service rendered was excellent.

Maintenance of adequate pressure is important in relation to the interim report under review—a point brought into sharp relief during the discussion by the contribution of M. Bolzinger, who called attention to the effects of pressure changes in reducing the 'interchangeability zone.' Overall, in France it has been necessary seriously to reduce the limits within which gas supply characteristics should be allowed to vary. For example, it has been found from experience that for domestic application the Wobbe number should not be allowed to vary more than ±5% and for industrial use not more than ±3%. Again, we had the pertinent comment from another speaker in the discussion that, if designed and adjusted for a gas supply of constant quality, domestic gas appliances could be operated on average at an efficiency at least 10% higher than now generally obtained.

Then, of course, certain industrial processes, such as precision flame heating, call for a gas supply kept within very close limits of variation. And in the industrial field there is a further reason why the chemical composition of the products of combustion should be maintained within close limits, and that is where town gas is used for the provision of controlled atmosphere. The amount of gas sold for this purpose is not large in relation to total industrial gas sales, but, as was so rightly emphasised in the discussion, the type of work treated in controlled atmosphere furnaces is normally intrinsically costly. Faulty heat treatment of some of the newer metals and alloys, directly traceable to variation in town gas quality, cannot be tolerated, and it is unfortunate that several important industrial firms have recently been obliged to install their own special controlled atmosphere gas plant because they could not rely on town gas for the purpose. Unheralded changes in town gas composition are not a good advertisement for gas in industry, and integration of gas supply can in fact make it easier to 'ring the changes.' All of which reinforces our views that the 'satisfaction triangle' which is the basis of the report by Gilbert and Prigg should be used with austerity.

One more point before we close this brief note on the 'red triangle.' With high-pressure distribution and the copious admixture of numerous other gases to coal gas, does it follow that the composition of the gas at the consumers' burners will invariably tally with that sent out from the manufacturing station? Mention was made during the discussion on the report of the possible loss of 20 to 30 B.Th.U. per cu.ft. in high pressure systems supplying a composite gas containing a considerable proportion of hydrocarbon-rich oil gas, the loss being occasioned by the deposition of liquid hydrocarbons resulting from compression. It was suggested that the consequent lowering of the Wobbe number might move the gas outside the desirable range of performance. In research the solution of one problem leads to the posing of another, and the 'red triangle' may well be regarded as a zone of controversy.

Oil and Coal

BEFORE the denial of the Suez Canal and the closure of the I.P.C. pipeline about 80% (100 mill. tons per year) of Europe's oil needs were normally obtained from the Middle East. Because of the reduced tonnage which must be carried by tankers round the Cape only about 60% of Europe's estimated requirements will be received. To secure one extra ton of oil for Europe, two extra tons of production would be required in the Western Hemisphere because it is necessary to offset against the increased production the loss of the Middle East oil which would otherwise have been transported by the tankers diverted to the shorter North American run. Even if this increase in production could be secured, the co-operation of the companies and the most efficient use of tanker tonnage would be essential to raise the level of supplies in Europe from 60% to 75%. Expert opinion suggests that an increase in Western Hemisphere production of 600,000 to 800,000 barrels a day—the amount necessary to maintain a supply level of 75% of normal requirements—is within the capabilities of producers in the United States and Venezuela, but in the present circumstances more than commercial incentive alone is needed to bring forth the additional oil. Until a major increase is achieved European stocks will fall rapidly, despite the introduction of severe restrictions which are estimated to reduce consumption by 20% overall.

The O.E.E.C. has agreed that in the event of a shortage the burden should be shared by member countries on a fair and equitable basis and has set up a Petroleum Industry Emergency Group; national committees of oil distributors in each country will supply the organisation with statistics on national stock levels and estimated arrivals.

Meanwhile industry is looking for alternative fuels and some strange ones are being suggested. In the case of the gas industry, which, it is estimated, will lose a quarter of the 500,000 tons of oil it consumes each year, the replacement fuel must be coal—220,000 tons of it,

or well over 100,000 tons during the coming winter months. Tentative estimates of extra demands for coal this winter by general industry suggest a figure of 500,000 tons of which not more than 150,000 tons will be required by the electricity industry. As the *Manchester Guardian* has pointed out, even allowing an extra four weeks' supply to the railways—1 mill. tons—it would seem that the National Coal Board would have to supply altogether no more than an additional 2 mill. tons this winter. This would still leave 2.7 mill. tons as a safety margin. The Board is better equipped to meet a fuel crisis than in any winter since the war and coal stocks are the largest for 11 years. Much will depend on the weather, and in this respect we must be thankful for what appears to be a peculiarly extended autumn.

The Smithfield Show

WITH the memory of so many fine displays by the Gas Council at our major national exhibitions fresh in our mind, it was with some disappointment that we failed to find the industry represented at this year's Smithfield Show at Earls Court. We have no doubt that the reasons for the Council's absence—economic ones—were sound enough and we believe that they may return to this show in due course. Nevertheless, it seemed unfortunate since at certain of these big shows there is a prestige value which outweighs other considerations—more especially when one sees the electrical industry represented, as in this instance, by a comprehensive display by the British Electrical Development Association. Having inspected the B.E.D.A. display at Earls Court—incidentally a very good display reinforced by attractive models of grass and crop drying equipment—we felt there were few applications which could not be equally efficiently carried out by gas or coke.

Setting off in search of anything else at Earls Court which might interest the industry we soon found a stand which struck a familiar chord, though it featured something quite new to this country. This was equipment for the injection of anhydrous ammonia or other nitrogen solutions beneath the surface of the soil. Those gas boards who have concerned themselves with the application of gas liquor to the land will immediately see the implications of this new development—offering as it does the means of applying nitrogen in a much more concentrated form than is possible with 10 oz. liquor and thereby saving transport costs.

The application of nitrogen to the soil by the injection of anhydrous ammonia was developed in the United States some quarter of a century ago. Today, over 22% of all the nitrogen used agriculturally in the States is applied in this form, representing around 400,000 tons. It is, of course, a gas stored and conveyed as a liquid under pressure which reverts to gas on release into the soil. It contains no less than 83% of nitrogen, which is approximately four times that present in sulphate of ammonia.

It is worth noting that the Shell Chemical Company are erecting plant at a cost of £6,500,000 at their Shellhaven refinery for the production of anhydrous ammonia, from which it is anticipated that quantities will be available for extended trials in this country. The question immediately comes to mind: Can the gas industry share in this new development and would it be an economic proposition to do so? We believe there are no insuperable difficulties in the production of anhydrous ammonia at many gasworks. It might well solve a number of existing disposal problems and perhaps meet farmers' requirements more efficiently than is possible with gas liquor as at present applied.

There are, however, certain aspects of this new development which must be approached with caution. One would not wish to see it replacing gas liquor entirely as a nitrogenous fertilizer, since in our present method of applying liquor to the *surface* of the ground there are claimed to be advantages in the control of weeds and possibly also of harmful micro-organisms which would be lost by injection beneath the surface. On the other hand, this may well be the ideal means of predressing arable seedbeds and for fertilizer placement in rowcrop work—for which latter purpose it was obvious that the particular machines on show at Earls Court were designed. For general arable or grassland work we should think that additional injector tines would have to be added, bringing the spacing down to something like one foot intervals.

The 'applicator,' as it is called, embodies a 100 or 150 gal. tank, which would be sufficient for probably at least ten acres. The equipment is complete with metering pump to ensure an accurate predetermined amount of nitrogen per acre. Both trailer and tractor mounted models are available. (The agency in this country is in the hands of L. H. Watson, Ltd., of Waltham Abbey, Essex.)

Under cold conditions anhydrous ammonia is inhibited and the conversion into nitrates slowed down—so that the material can, it is claimed, be injected much earlier than the plant's requirements. The onset of warmer weather will trigger its availability. By reason of the somewhat elaborate equipment and the transport and storage arrangements involved, it seems that this is likely to be a contractual job rather than one for the individual farmer—at all events in the early stages. In America, for example, the anhydrous ammonia is stored at the manufacturing points in Hortonspheres holding from 1,500 to 2,500 tons under refrigeration, and is thence conveyed to distribution centres by road tankers of up to 6,400 gal. capacity, by rail tanker, or by barge containing pressure tanks to farmers' 'nurse' tanks of 1,000 gal.

Similar equipment is available for the injection of other nitrogenous liquids, which suggests the possibility of applying concentrated gas liquor in this way.

Mobile Briquetting in Hungary

EXPERIMENTAL production of briquettes made from coal dust and slack has begun at the Csepel brick factory in Budapest, Hungary. It is estimated that the new method will make usable some 200,000 to 250,000 tons of dust and slack a year.

A binder of crude oil and bitumen is used, the mixture being pressed in an ordinary brick press to make a briquette suitable for domestic heating.

The process is very cheap: A brick press costing £2,400 can make about 240 tons of briquettes daily.

The Ministry of Home Trade plans to put presses on lorries which can visit areas where large quantities of dust and slack are stored and process them on site.

Personal Notes

MR. J. D. C. WOODALL has been appointed Assistant Commercial Manager (Sales), and MR. A. G. BARSON, Assistant Commercial Manager (Administration) by the South Eastern Gas Board from January 1. Mr. Woodall entered the gas industry as a Pupil Engineer of the Gas, Light and Coke Company in 1933 and was later seconded to the South Eastern Gas Corporation, first with the Folkestone and Dover Gas Companies and then with the Maidstone Gas Company of which he became Engineer and Manager in 1939. After nationalisation he remained as Manager of the Maidstone Group of the South Eastern Gas Board until 1953 when he was appointed Sales and Service Manager, Kent County. Mr. Barson entered the Indian Civil Service in 1939. In 1948, after his return from India, he was appointed Secretary to the newly formed Basildon Development Corporation and later became Assistant General Manager. He was appointed Assistant Secretary to the South Eastern Gas Board early in 1954.

MR. WALTER MASON, local Superintendent for the East Midlands Gas Board at Oakham, Rutland, has retired after 51 years' service in the gas industry at Oakham. He succeeded his father in 1917 as Engineer and Manager at Oakham gasworks and continued until nationalisation, when he became local Superintendent.

COUNCILLOR C. M. WILSON, of Horsforth, Leeds, has been appointed a Member of the North Eastern Gas Consultative Council.

MR. H. H. LUSTY has been appointed Manager, Publicity Department, by Metropolitan-Vickers Electrical Co., Ltd., from January 1. He succeeds MR. E. E. WALKER who is retiring but will act in an advisory capacity until the end of January.

MR. C. H. WILSON has been appointed a Director of Cochranes (Middlesbro') Foundry, Ltd., of which Company he remains General Manager. He has not been appointed a Director of The Stanton Ironworks Co., Ltd., as stated in our December 5 issue.

MR. A. L. CURTIS has been elected a Director of the United Coke and Chemicals Co., Ltd., a subsidiary of the United Steel Companies, Ltd. Mr. Curtis will continue in the post of Operations Manager.

MR. H. J. PATCHING has been appointed General Manager of the Montevideo Gas and Dry Dock Co., Ltd., in Montevideo, from December 1, in succession to MR. W. A. H. KEELEY.

MR. JAMES CAMPBELL, former District Manager at Montrose, has now taken up his duties as Manager of the Galashiels Sub-Group of the Scottish Gas Board.

MR. R. L. LAING, Gas Manager at Brechin (Angus) for over 20 years, is to retire shortly owing to ill-health.

LORD GEDDES, of Balerno, Midlothian, has been appointed a part-time Member of the Scottish Gas Board.

Colonel William Moncrieff Carr, C.B.E., T.D.

AN APPRECIATION BY SIR HENRY JONES, M.B.E., PRESIDENT OF THE INSTITUTION OF GAS ENGINEERS

ALTHOUGH I had known Colonel W. M. Carr from an earlier date, I first became closely associated with him during the 1930's after he had joined the Board of the United Kingdom Gas Corporation, Ltd. Then at the height of his powers he was an indefatigable colleague.

An engineer with an intimate knowledge of every detail of a gasworks, he thought big. Heavy expenditure of capital did not worry him provided that an adequate income would be earned.

He realised that only by making gas cheaply could attractive terms be offered to the consumer, and he fully understood the importance of by-products to the economics of carbonising plant. He recognised the possibility of using the coke-oven to make really cheap gas.

Always a crusader, Billy Carr knew that the gas industry must sell or die. The domestic two-part tariff (a shilling a week and half-price gas); the special contract for the big industrial consumer; the cooker, mass produced to a standard specification and sold on ten-year hire-purchase were all weapons in his sales armoury.

At heart, however, he remained an engineer. A walk round one of the works for which he was responsible would usually reveal some new idea, and always a high standard of maintenance and operation.

After the war, although sometimes not very fit, he showed the same tremendous energy, and the old cheery smile remained the same. When he became the first Chairman of the North Western Gas Board he set about the task of organisation using some of the methods already familiar to him from his holding company experience.

His staff, many of whom he had trained himself, were invariably loyal and devoted to 'The Colonel' no matter how hard he drove them. Hard driver he was—of himself as well.

Off parade he was always good value, whether telling of a new horse which he had bought or of a run with hounds; or perhaps recounting some experience during one of his annual visits to the Dublin Horse Show. He was a 'character' in the best sense of the word and kindness itself to his friends.

A past President of The Institution of Gas Engineers, he was made an Honorary Member in 1955. Through the men he trained his influence will be felt in the gas industry for many years to come.

Obituary

MR. C. STREDWICK, Chief Accountant of the South Eastern Gas Board, whose death was announced briefly last week, started work as a junior clerk with the former South Metropolitan Gas Company, Old Kent Road, in 1915. In 1929 he joined the Sutton Gas Company as Secretary and Accountant. When the Company was subsequently amalgamated with the Wandsworth Gas Company he became Deputy Accountant, and, afterwards, Chief Accountant. On nationalisation he was appointed Chief Accountant to the South Eastern Gas Board, where his mastery of figures and his ability to make them understandable to those who had not his technical knowledge and skill, were outstanding. He was a Fellow of the Chartered Institute of Secretaries, the Association of Certified and Corporate Acountants, and the Institute of Taxation.

MR. H. P. T. LIND, Chairman of Peter Lind & Co., Ltd., died on December 1 after a short illness.

Diary

December 13.—COMBUSTION ENGINEERING ASSOCIATION: Chamber of Commerce, 9, Quebec Street, Leeds 1. 10.30 a.m.

December 14.—JUNIOR INSTITUTION OF ENGINEERS: Pepys House, 17, Rochester Row, Westminster, S.W.1. 7.30 p.m. Inaugural Meeting: Presidential Address—'Fuel Economy and Combined Heat-Electric Generation,' by Bryan Donkin.

December 14. — INCORPORATED PLANT ENGINEERS: Imperial Hotel, Temple Street, Birmingham. 7.30 p.m. Mobile Plant Discussion Group.

December 14.—SCOTTISH G.C.C.: 26, Drumsheugh Gardens, Edinburgh. 11 a.m.

December 18.—INSTITUTION OF CIVIL ENGINEERS: 'Post-War Developments in the Coal Mining Industry,' by Andrew Young, H. A. Longden, and B. L. Metcalfe.

December 19. — INCORPORATED PLANT ENGINEERS: King's Head Hotel, High Street, Rochester, Kent. 7 p.m. 'Plant Planning and Development,' by A. W. Western.

December 19.—LONDON AND SOUTHERN JUNIORS: Visit to Reed Paper Mills, Aylesford, Kent. 2 p.m.

BUSINESS ACQUIRED

Lancashire Dynamo Holdings have acquired the business of J. G. Statter & Co., Ltd., electrical switchgear manufacturers, of Amersham Common, Bucks. For this purpose, the capital of Lancashire Dynamo Holdings has been increased to £3,000,000 by the creation of 500,000 ordinary shares of £1 each.

S.W.G.B. CHIEF WARNS EMERGENCY GAS USERS

'We might have to cut you off'

IF industrialists and others who now used oil for heating processes were contemplating the permanent or temporary use of gas this winter, it would greatly facilitate arrangements if they would discuss the matter with the Board as soon as possible, so that the magnitude of the additional gas demand could be calculated and steps taken to cope with it, said Mr. C. H. Chester, C.B.E., in a statement to the South Western Gas Consultative Council at Taunton last week.

While the Board was anxious to assist in every way possible, those who, owing to the restriction on the supply of oil, had approached them for a gas supply, a sudden and comparatively large increase in gas demand by such industrialists and others might create a total demand in excess of the gas available.

Should these conditions occur, due to the total additional load being excessive and the winter being exceptionally cold, the Board would be bound to limit or probably interrupt the supply of gas for a few days to consumers using it as a temporary expedient. The Board would not accept additional temporary loads likely to jeopardise the supply of gas to its permanent consumers.

Furthermore, since industrial and commercial gas loads were comparatively large, capital expenditure involved in making the supply available could be considerable and the Board would be bound to arrange terms which would guard their financial position.

For oil consumers who could use, or would prefer to use, coke as a standby fuel, the Board's stock of coke in the South West was adequate, though the petrol position might make delivery to a time schedule difficult.

Sir Harold Smith, K.B.E., Chairman of the Gas Council, helps Miss Ada Read put on the gold watch presented to her in recognition of her 40 years' service in the gas industry.

CHANCE IS OFFERED OF STUDY ABROAD

Robert Blair Fellowships

APPLICATIONS are invited by the London County Council for the award of the 1957 Robert Blair Fellowship, which is tenable for one year of advanced study or research overseas in applied science and technology. The value of the award varies according to the country chosen by the person to whom it is made and may be as much as £2,000 in the case of Canada or the United States.

Candidates must be natural born British subjects and at least 21 years of age. Fellowships are open to suitable candidates, men or women, who have been trained in applied science and technology, but preference is given to engineering science and to those who have completed a course of study in London institutions or who have been identified with the London teaching service.

The Robert Blair Fellowships were established by the L.C.C. in 1925.

15,000 WILL SHARE BRITAIN'S FIRST NATURAL GAS

BRITAIN'S first-ever domestic consumers of natural gas—as a result of the Scottish Gas Board Cousland project, reported in these columns last week—will number some 15,000.

Well-head pressure of the gas—60 lb. per sq. in.—will be used, after suitable reduction by governor, to send it through four miles of main to Musselburgh gasworks for mixing with coal gas before distribution to consumers.

Cost of this latest British natural gas enterprise is expected to be about £25,000.

Sale of Industrial Gas Falls in W.M.G.B. Area

FOR the first time since the 1952-53 recession, industrial gas sales were lower than in the corresponding period of the previous year, the Chairman of the West Midlands Gas Board, Mr. G. le B. Diamond, told a West Midlands Gas Consultative Council meeting in Birmingham on November 26, in a report for the six months ended September 30.

In Birmingham the total consumption of the 50 largest consumers in September was 20% below the figure for the corresponding month the year before. Sales to commercial users, however, had continued to rise, while total domestic sales appeared virtually unchanged, continued Mr. Diamond.

Coal and oil stocks—despite the Suez situation—were good. Coal consumption for gasmaking, at 1,482,500 tons, was 3.5% down. Despite reduced production and increased consumption, for making water gas, coke stocks had increased and were 158,000 tons at the end of the period, against the previous year's record stock of 110,000 tons.

Natural gas?—but none more natural!

BRITAIN'S search for natural gas has so far failed to unearth significant quantities, Dr. A. E. Haffner, Chief Engineer of the Southern Gas Board, told a Southern Gas Consultative Council meeting in Bournemouth, recently, during a talk on 'New Methods of Gas Production.'

But what gas could be more natural than that derived from the fermentation of sewage? Dr. Haffner asked his listeners. (He did not, however, clarify whether this should be classed among new or old methods of gas production.)

Care is taken in large sewage works to collect this gas and use it for pumping and traction about the works, explained Dr. Haffner. Protagonists of fermentation calculate that a family of four could be kept in heat and light by the gas produced from the fermentation of waste products of one cow.

But, Dr. Haffner warned his audience —presumably to curb any impetuous urge among them to rush home and dabble in this form of gasmaking on their own account—it is better to leave it to the gas industry—particularly if you live in a flat!

To those of his listeners who may be interested in delving deeper into the matter than Dr. Haffner took them we would draw attention to the account of Indian pioneering in this form of gasmaking which appeared on p. 533 of our May 23 issue under the heading 'Thereby Hangs a Tail . . .'

BRITISH FIRM WINS ANOTHER £2 MILL. EXPORT ORDER

ANOTHER £2 mill. coke oven installation has been ordered from Woodall-Duckham Construction Co., Ltd., by the South African Iron & Steel Industrial Corporation, Ltd., for their Vanderbijl Park works.

This is the ninth battery of W-D Becker coke ovens to be ordered by ISCOR and the fourth within the last two years. It comprises 55 ovens, as does the battery now nearing completion at Vanderbijl. Two further batteries of 51 ovens are also under construction at the Pretoria works. The total value of these four contracts approaches £6 mill.

ISCOR's continuing development is both an indication of and a vital contribution to the rapid industrial expansion which is taking place in South Africa. All the refractories and a major proportion of the steelwork and ironwork, including the oven machines for the new coking plant, will be fabricated in that country.

In addition to the battery and machines the new contract includes a complete by-product recovery plant, coal blending and handling and coke handling plants and civil engineering work. When this plant is completed the Vanderbijl works will carbonise about 3,600 tons of coal daily.

It's an ill wind . . .

'WE have been losing consumers to oil, but now we may get them back again,' said Sir Robert Nimmo, Chairman of the Scottish Gas Consultative Council, when he opened new gas showrooms in St. David Street, Brechin.

He forecast that in the future Angus gas supplies would come from Perth and Dundee. The Scottish Gas Board was laying a main from Coupar Angus to take the Perth supply to Forfar and Kirriemuir.

Gas at 20s. a 1,000 cu. ft.— Irish Rumour

COLERAINE, Co. Londonderry, has been having a 'whispering campaign' alleging that the price of gas was going up to 20s. per 1,000 cu.ft.

But it was all a rumour, Alderman D. J. Christie, Deputy Mayor, told a Borough Council meeting. And it arose because the Council asked the Ministry for permission to raise the maximum permissible price to 20s. per 1,000 cu.ft.

There had been a misunderstanding, said the Mayor, Alderman S. J. Henry. The increase intended would not be a frightening one.

Gas production had fallen during the year, said the Gas Manager, Mr. T. R. Cameron. Loss of public lighting had cost 1 mill. cu.ft., and a further 600,000 cu.ft. decrease was due to gas now being measured at lower temperature.

News from All Quarters

DUKE OPENS NEW PLANT WITH SILVER BLOWPIPE

USING a silver-plated oxy-acetylene blowpipe, the Duke of Devonshire recently cut a thin metal strip thereby closing an electric circuit and setting in operation a new liquid oxygen producing plant.

The Duke was officially opening a new British Oxygen Gases, Ltd., factory at Brinsworth, near Rotherham. It is one of six new plants the Company is installing to meet growing industrial gas requirements in Britain.

The opening of the new plant marks the culmination of three years' work and the expenditure of more than £1 mill. The entire project, when completed, will cost double this figure.

Quick off the mark in coming to their aid, Cardiff Undertaking of the Wales Gas Board has devoted the window of their City showroom to the support of the appeal for help for Hungarian refugees in the Save the Children fund. More than £300 was collected in the first ten days.

Objection to the use of the words male and female in reference to employees was discussed at a recent meeting of the North Eastern Gas Consultative Council in Leeds. A resolution calling on the Board to make higher allowances on used gas appliances was defeated.

Following the recent successful experiment in Glasgow, the Scottish Gas Board and Australian Trade Publicity are to extend their co-operation, using Australian foods and recipes in gas cooker demonstrations.

GAS LIGHTING PRICED OFF BELFAST ROADS

GAS lighting Belfast's main roads costs £2,354 a mile—against electric lighting at £588 to £1,016 a mile. So the gas lights are to go.

This decision was reached by the Corporation Police Committee on December 6. It is subject to City Council approval.

The Gas Department Manager said the reason was tremendous increases in the cost of coal and wages. He believed gas could still compete for lighting side streets.

TENANTS TO BEAR COST OF COOKERS IN ABERDEEN

AFTER January 1 Corporation tenants in Aberdeen will have to provide gas and electric cookers at their own expense, the Town Council has decided.

Precluded from voting on the issue by the ruling of the Scottish Secretary, eight Socialist councillors who are also Council tenants could take no part in deciding future policy on cookers. This left the Progressives with a majority, and their 'No more free cookers' proposal was carried by two votes.

The debate was prefaced by a statement from the Town Clerk, who said the North of Scotland Hydro Electric Board had indicated unofficially that should the Corporation depart from their former policy the Board might require to increase their service charge.

CARDIFF SHOWROOM IS SCENE OF FIFTH ART SHOW

THE work of five Cardiff professional artists was shown recently at the fifth exhibition of art arranged by the Cardiff Undertaking of the Wales Gas Board in the City Showroom at St. John Square. These exhibitions have ranged from reproductions of paintings by Picasso to original works by young painters and sculptors of promise in the district.

Cardiff has no art gallery, apart from the Museum, where painters can exhibit their works; the Cardiff Undertaking has for this reason put on these shows to encourage and help artists who are trying to make their way in the world of art.

The exhibition was opened by the Lord Mayor of Cardiff who was accompanied by the Lady Mayoress. Over 100 people accepted invitations to be present.

NEW G.C. CATERING EQUIPMENT LIST

A NEW addition to Gas Council publications is a list of tested and approved gas catering appliances. It is to be published annually.

Available now free of charge from area gas board offices and showrooms, the list is issued as a companion publication to the Council's 'List of Tested and Approved Domestic Gas Appliances.'

All the appliances on the list have been tested in accordance with British Standard 2512 (1954), 'Gas Heated Catering Equipment.'

Palatial Showrooms Open in Blackpool

BLACKPOOL'S quarter of a million population and seven million seasonal visitors have been provided by the North Western Gas Board with some palatial new showrooms. They are on a prominent corner site in the town, and the striking blue and cream colouring of the exterior with its modern, streamlined design, and the contemporary, colourful furnishings of the interior have already attracted much comment and some controversy. Opening the showrooms, the Mayor of Blackpool, Alderman H. Henson, J.P., referred to the tremendous and progressive strides taken by the gas industry, and said: 'We should be thankful here that we have such a wide-awake gas board to take care of our interests.'

Mr. A. K. Collinge, General Manager of the North Western Gas Board's West Lancashire Group, said that he regarded the new showrooms as the finest in the North West. 'If there is any town in the country or in the whole world which appreciates the value of good publicity and good advertising I am sure that town is Blackpool,' he said. 'We sincerely hope that these showrooms will be considered by the people to be in keeping with the go-ahead spirit which animates the town, and which is indeed the very livelihood of Blackpool.'

One of the most attractive features about the new building is the theatre for film shows, cookery demonstrations and other meetings. There is seating for 160, and the furnishings are most attractive. The upholstery is in red and grey, the walls are in deep lilac and paler shades, the ceiling is the palest primrose, the maroon curtains are threaded with untarnishable metal thread, and the carpet is a combination of red, grey, primrose and lilac.

A spacious lower floor features large ranges, grills, tea and coffee urns, and other equipment of interest to Blackpool's huge catering and boarding house industry.

* * *

Pictured on this page (above) is the exterior of the new Blackpool showrooms; (centre) the attractive main sales floor; (left) catering equipment on the lower sales floor; and (foot of page) Mrs. Welman, wife of the Chairman of the North Western Gas Board, Mr. D. P. Welman, speaking at the official opening. Beside her (from left to right) are: Mr. A. K. Collinge, the General Manager of the Board's West Lancashire Group; the Mayor and Mayoress of Blackpool, Alderman and Mrs. H. Henson; and Mr. J. W. Rodgers, the Board's Sales and Service Officer.

From a paper to the 22nd Autumn Research Meeting of The Institution of Gas Engineers

The Prediction of the Combustion Characteristics of Town Gas

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A METHOD of predicting the combustion characteristics of a gas from its analysis is presented. The method is based upon the methods of Delbourg in France and of Weaver in America. It has been developed and modified for use under British conditions.

A number of gases that are used or have been proposed for use in the town gas supply have been examined by the method, and samples of some of these gases have been made up in the laboratory and their characteristics determined. Agreement between the predicted characteristics and those found is reasonably good.

The method involves the use of a calculated flame speed and, therefore, cannot be considered as completely satisfactory; check testing of existing appliances thus remains necessary. Nevertheless, the types of unsatisfactory performance that are liable to occur with a particular gas are indicated and the testing of appliances on samples of the new gas can be reduced to a minimum.

[Though certain references to Appendices are included in the following abstract of the paper, the Appendices themselves are not included—Ed. 'G.J.']

Knowledge of Combustion Characteristics

The problem of the combustion characteristics of town gas is one that the gas industry in Great Britain has had under review for a considerable time The early work of the Institution of Gas Engineers Gas Investigation Committee in the years immediately after the First World War, followed by that of the Joint Research Committee of the Institution of Gas Engineers and the University of Leeds, laid the foundations of our knowledge of the performance of burners and of the variation in combustion characteristics to be expected at that time. The work of the former Gas Light and Coke Company and of the former South Metropolitan Gas Company in the decade 1935 to 1945 enabled test methods and apparatus to be formulated. The aim of the work was to ensure that the gas industry should have the greatest possible flexibility relative to the variations in the demands for gas and coke, without interfering with the service given to its consumers.

In the decade since 1945, the aim of workers in this field has remained the same, but the problem has become more complex. The gas industry is finding it more difficult to obtain the best grades of gas-making coal and is turning to alternative materials. Among such materials are non-caking coals, oil, refinery gas, methane from coal mines, and possibly natural gas either from Great Britain or from oil-fields abroad. The methods and plant by which town gas can be produced from these materials has been reviewed by Dyde[1]. It is not clear, however, whether the gas produced by these processes can be supplied instead of, nor how far it can supplement, the existing supplies. Burners and appliances can be designed for any type of gas, but it is not possible to ensure high efficiency or satisfactory service with a wide variation in combustion characteristics, particularly on the existing appliances out in quantity on the district.

The problem has arisen in an even more acute form in other countries. In the United States of America, the change-over from manufactured gas to natural gas and the problem of meeting peak-load demands have stimulated interest in the subject, while in France gas has been produced from a very wide range of raw materials. In America, the work of Weaver[2], and in France that of Delbourg[3] has become associated with what is generally referred to as the interchangeability of gases. Both these workers have given methods by which the suitability of a gas for use in an existing supply can be assessed. The two methods appear to be very different, but it has been shown that they are similar in principle[4]. The methods are difficult to apply directly to British conditions, for not only are appliances and burners different in the various countries but so also are the test methods and methods of expressing combustion characteristics.

This paper is an attempt to combine the two methods and relate them to British conditions. Both methods are largely concerned with the performance of an appliance on a gas relative to an adjustment gas—that is, the problem of interchangeability. This is probably the most important problem, but it is also important to know the combustion characteristics of a gas in order that burners and appliances may be designed for it. The paper gives details of a method by which these combustion characteristics can be assessed by calculation from the analysis of the gas.

Probably the most important properties of a gas affecting the combustion characteristics are: Calorific value, specific gravity, and burning velocity. The first two decide the heat input to the appliance and are combined in the Wobbe number.

The calorific value is approximately proportional to the air required per cubic foot of the gas for complete combustion, so that the Wobbe Number, apart from its well known use as an index of heat input, may indirectly measure other properties. In America, the factor $A/\sqrt{d}$, where A is the air required per cubic foot of the gas and d is the specific gravity, is taken as an inverse measure of the relative primary aeration of an aerated burner. The same factor can also be used as a direct measure of the air required per unit time for complete combustion.

Significance of the Wobbe Number

Over a wide range of Wobbe Numbers, there is good agreement between Wobbe Number and the factor $A/\sqrt{d}$ for a number of British gases, and the relationship can be expressed approximately as $W = 115\ A/\sqrt{d}$, where W = Wobbe Number. Thus the Wobbe Number of a gas may measure directly or indirectly several important factors contributing to the combustion characteristics.

The burning velocity of a gas is difficult to express as a single factor, for it varies with the proportions of gas and air in a mixture, reaching a maximum at approximately the theoretical proportion of air to gas. This maximum value may, however, be used to compare the burning velocities of gases and it has been suggested[5] that, at least to a first approxim-

tion, the burning velocity[11] aeration curves for various gases can be superimposed one upon another if the axes are expressed as fractions of the maximum burning velocity and of the air required for complete combustion.

The burning velocity of the gas-air mixture in an aerated burner has an important effect on the tendency of the flames on the burner to lift or light back. The maximum burning velocity is also important in the phenomenon of lifting of flames from non-aerated burners.

The measurement of burning velocity in absolute terms is difficult to achieve, and for this reason burning velocity is seldom assessed in examining gases for their combustion characteristic. Reliance is placed, instead, upon the use of test burners, which measure a combination of the factors that are important. The standard instrument in this country is the aeration test burner. For less precise work, the flame matching burner may be used, and Mills[6] has indicated the relation between these two burners. Fuidge and Dewhurst[7] have recently confirmed that the aeration number gives a good indication of the tendency for a gas to light back on aerated burners.

From experience with the various types of appliances in use in this country, it is possible to lay down limits to the properties of a gas in order to avoid unsatisfactory performance. Some of these limits are familiar, since they are incorporated in British Standards for the routine testing of appliances to ensure that they have sufficient tolerance to changes in gas quality. The limits are dealt with briefly below and are summarised for a G4 gas (*i.e.*, a gas with an average Wobbe Number of 730) in Table 1. More detailed consideration is given to these limits in the Appendices.

An appliance will generally give satisfactory performance if the heat input to it is maintained within ± 10% of the adjustment value. In order to meet this requirement the Wobbe Number of the gas must be maintained within ± 10% of its mean value.

The tendency of a gas to light back on aerated burners can be assessed by means of the aeration test burner. For a given setting of appliance burners, the limit for light back corresponds to a particular Aeration Number. Incomplete combustion is associated with high Wobbe and aeration numbers relative to the adjustment gas.

Non-aerated burners more readily give rise to lifted flames than do aerated burners; the limit, therefore, should be fixed with respect to the former. The most important measure of the lifting tendency of a gas is the reversion pressure. (Appendix 2). This is the pressure at which a lifted flame, obtained at a higher pressure, will return to the burner head. The reversion pressure depends, among other things, upon the area of the burner port, and a detailed picture of the lifting tendency of a gas can be obtained by plotting the reversion pressures for variously sized jets against their burner port areas. A comparison of different gases can be made, however, by the determination of reversion pressures on one size of burner. The burner chosen for this comparison has been a Bray jet No. 266, size 3.

The mechanism of soot formation in non-aerated flames is complex. Any hydrocarbons present in the gas can produce soot under certain conditions, but the aromatic hydrocarbons are by far the most liable to do so. The presence of soot-forming hydrocarbons in the gas gives rise to a luminous fringe at the top of a non-aerated flame, and the height of this fringe, measured under standard conditions on a Bray jet No. 266, size 1, is taken as a measure of the sooting tendency of a gas (Appendix 5).

Table 1.—Performance Under Abnormal Conditions

Property	Measurement	Average Value	Normal Range	Limiting Values	Appendix No.
Heat input	Wobbe Number	730	700 to 760	655 to 800	
	Specific Gravity for C.V. = 500 B.Th.U. per cu. ft. ..	0.47	0.51 to 0.43	0.58 to 0.39	
Lighting back	Aeration Number	67	60 to 75	50	4
Incomplete Combustion	A. No. and Wobbe Number	67 730	60 to 75 700 to 760	85 800	3
Lift	Reversion pressure (in w.g.) ..	—	2.5 to 3.0	1.8	2
Sooting ..	Benzene fringe (mm.)	—	0 to 5	8	5

Within the normal range, excellent performance results. At times of peak load, or at other times, the gas may approach the limiting values when appliances begin to give unsatisfactory performance. The precise position of such limits is not easy to fix, partly because of the large variety of appliances in use, but also because of the change in performance of appliances as parts corrode or become dirty. The overload margin in British Standard combustion tests is designed to allow for change in use and for variations in the manufacture of appliances.

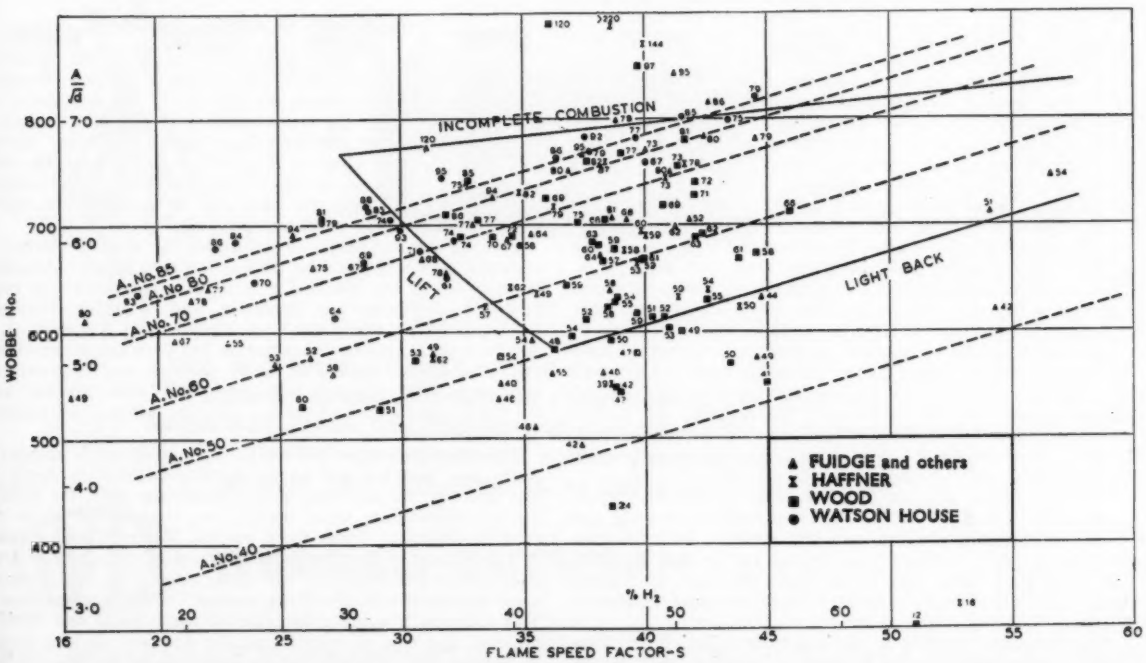


Fig. 1.—Gases from the literature plotted to show the relation between aeration number, Wobbe number, and flame speed factor.

The only completely satisfactory method of assessing the suitability of a gas for a given district is to test the gas on a large number of representative appliances and to compare these results with those obtained on the gas as normally supplied. This is, of course, a lengthy process, and to overcome its disadvantages a number of methods for assessing the combustion characteristics of a gas, either from a small sample or from its analysis, have been proposed.

Bromilow[8] has reviewed and classified these methods while Anthes[9] has discussed them.

The most comprehensive of these methods of prediction are those of Weaver and Delbourg[2]. By these methods, attempts are made to predict most of the types of unsatisfactory performance given in Section III.

The methods have been discussed in detail in a previous publication (GC21)[4]. Broadly, Weaver calculates a series of six indexes for a gas relative to an adjustment gas and suggests limits to these for satisfactory performance. In the calculation of these indexes, the two factors $A/\sqrt{d}$ and S, the calculated maximum flame speed of the gas relative to hydrogen, are important. Delbourg uses a diagrammatic method in which Wobbe Number is plotted against 'combustion potential,' and an area of satisfactory performance is drawn on the diagram.

In Section III, it was shown that $A/\sqrt{d}$ and Wobbe Number are related, while in GC21 a graph of S against combustion potential for a number of gases showed a relationship to exist between these.

Interchangeability of Gases

It is clear, therefore, that the two methods are fundamentally similar. Both methods appear to provide a good indication of the performance of a gas, but they suffer from the disadvantage that the limits have been developed in terms of American and French appliances. The combination and adaptation of the methods to serve British conditions is discussed in section V.

Delbourg's graphical method of representing the combustion characteristics has several advantages. By this means, the characteristics of a gas can be readily judged, while the position of the gas relative to that of another gas indicates the type of performance to be expected on interchanging the gases. The possibility of mixing gases to improve performance can also be readily assessed. The graphical method has therefore been retained. The choice of axes for the diagram is discussed below.

Both Delbourg's combustion potential and Weaver's flame speed factor S represent methods of assessing the relative maximum flame speed of a gas. In order to ascertain which gave the better result, calculations by both methods have been compared with flame speeds measured by Wood[10] and Haffner[11]. It is reasonable to assume that Weaver's calculation gives an approximation to the relative maximum flame speed of a gas. Haffner's values gave a similar result. A plot of Delbourg's combustion potential against these measured flame speeds, however, gave a considerably wider spread. For this reason, and because Weaver's calculation appears more logical than Delbourg's combustion potential, the former has been used as an axis of the diagram (Fig. 1).

The method of calculating Weaver's flame speed factor S is in Appendix 1. The hydrogen content of the gas plays an important part in determining the calculated value of S. This is not unexpected in view of the high maximum flame speed of hydrogen relative to other gases. It is clear that hydrogen content can be used as an approximate measure of flame speed, and is a possible approximate alternative axis for the diagram.

It has been shown that Wobbe number and $A/\sqrt{d}$ are closely related. For the purpose of the diagram, the Wobbe Number has been used because it is more readily understood, it gives a measure of the heat input to appliances and it can be determined with a good degree of accuracy.

The axes of the diagram then are primarily Weaver's flame speed factor, S, and Wobbe Number, with hydrogen content and $A/\sqrt{d}$ as possible alternatives. The positions of a number of gases on such a diagram are shown in Fig. 1. The data for these gases have been taken from the work of Fuidge *et al*[12], Haffner[11], Wood[10], and from results obtained at Watson House.

The Aeration Number is an important criterion of combustion characteristics and is used in defining two of the limits of satisfactory performance. It is to be expected, therefore, that a relationship would exist between the position of gases on the diagram and their Aeration Numbers. In Fig. 1, the Aeration Number of each gas has been inserted by each point. It will be seen that the distribution of Aeration Numbers follows a regular pattern—high Aeration Numbers being associated with high Wobbe Numbers. By grouping the Aeration Numbers, it has been possible to insert on the diagram lines representing equal Aeration Numbers. The equations of these lines are given in Appendix 1(c). A relationship of test burner number, flame speed and Wobbe Number giving a similar result has been suggested by Schuster[13].

The spread of Aeration Numbers about the lines is quite considerable and it is thought that predicting of the Aeration Number can only be made to, say, the nearest five units.

Two Different Test Burners

There are probably several reasons for this spread of results. First, it should be borne in mind that the gases reported were tested in several different laboratories over a period of approximately 20 years using both A and B types of aeration test burner. The results on B-type burners have been calculated as Aeration Numbers by the formula

$$A = 1.6B + 8,$$

where A is the Aeration Number and B is the reading of the air shutter opening on the B-type instrument. Secondly, it is probable that the lines of equal Aeration Number are essentially lines of equal cone height. Delbourg,[14], for example, has given similar lines of rather steeper slope for equal cone heights. The aeration test burner, however, is adjusted to give a constant cone height and the Aeration Number is a measure of air shutter opening. That Aeration Number and cone height are related was shown by Mills[6]. There is probably, therefore, an instrument factor associated with the spread of results.

Thirdly, the flame speed has been calculated and therefore probably does not represent the true flame speed precisely.

Upon the diagram can be inserted the limits of satisfactory performance of appliances adjusted for G4 gas discussed in Section III. The methods by which these limits are inserted on the diagram are described below.

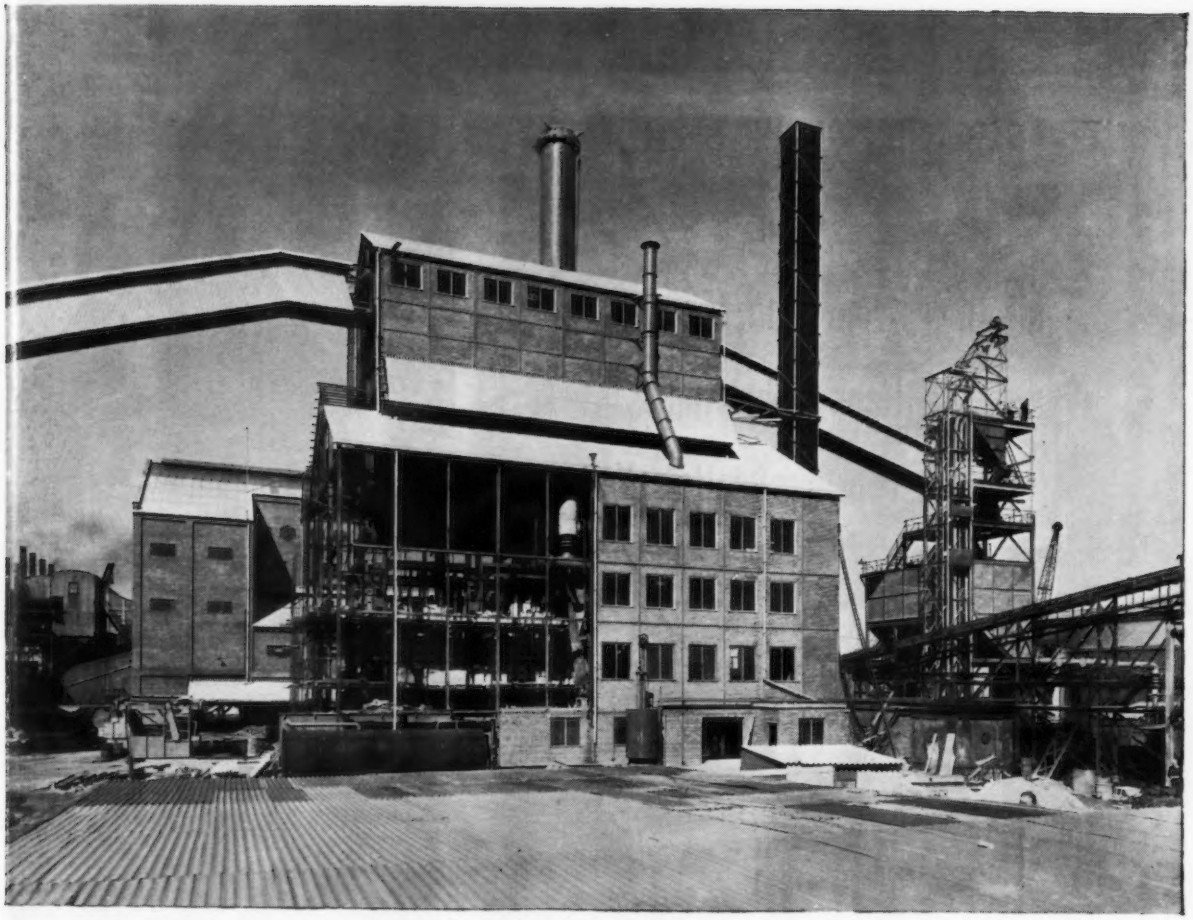
Since the vertical axis of the diagram is the Wobbe Number, it is clear that the limit of heat input at 10% lower than that of the average gas can be inserted at Wobbe Number 655. It is thought that the upper limit of Wobbe Number is very largely dependent upon the liability of appliances to give incomplete combustion, and as a separate limit for this is given below it was not considered necessary to insert the upper limit of Wobbe Number on the diagram.

Significance of Aeration Number

The tendency to light back is measured by the Aeration Number. For G4 gas, the limiting value is Aeration Number 50, and this limit is shown on Fig. 1. It was considered of interest to examine the characteristics of gases of Aeration Number 50, but of different flame speeds. 'Chaso' curves for such gases are given in Appendix 4. It is probable that all gases of this Aeration Number behave similarly with regard to light-back and that the limit can be considered as satisfactory over a range of flame speeds.

The limit of satisfactory combustion for aerated burners is assumed in B.S.1250 to be obtained with a gas of Aeration Number 85 at the nominal heat input. This limit has been criticised by Fuidge and Dewhurst[7] and is further discussed in Appendix 3. From the work described in Appendix 3, a new limit of satisfactory combustion has been suggested which, it is considered, applies to both aerated and non-aerated appliances. This limit is a function of Wobbe Number and the flame speed factor of the gas and can therefore be inserted on the diagram.

The phenomenon of lift on British appliances is comparatively new and has not so far been considered in detail in this country. It has been shown previously that, for British burners, lift occurs more readily on non-aerated than on aerated burners[4]. Some work on the lifting of non-aerated flames is described in Appendix 2, from which it will be seen that Weaver's criterion for the lifting of aerated flames shows good agreement with the lifting tendency of non-aerated flames. This criterion is again a function of flame speed and Wobbe Number and can be inserted on the diagram. It was found by Weaver that oxygen in the gas increased the tendency to lift: this was found to apply also to non-aerated flames, and Weaver's empirical correction for oxygen content has been re-



The W-D Intermittent Vertical Chamber Installation now being built by Woodall-Duckham (Australasia) Pty. Ltd. for the South Australian Gas Company at their Osborne, Adelaide Works. 20-3¾ ton chambers with a gas-making capacity of over 2½ million cu. ft. of 500 B.Th.U. gas per day.

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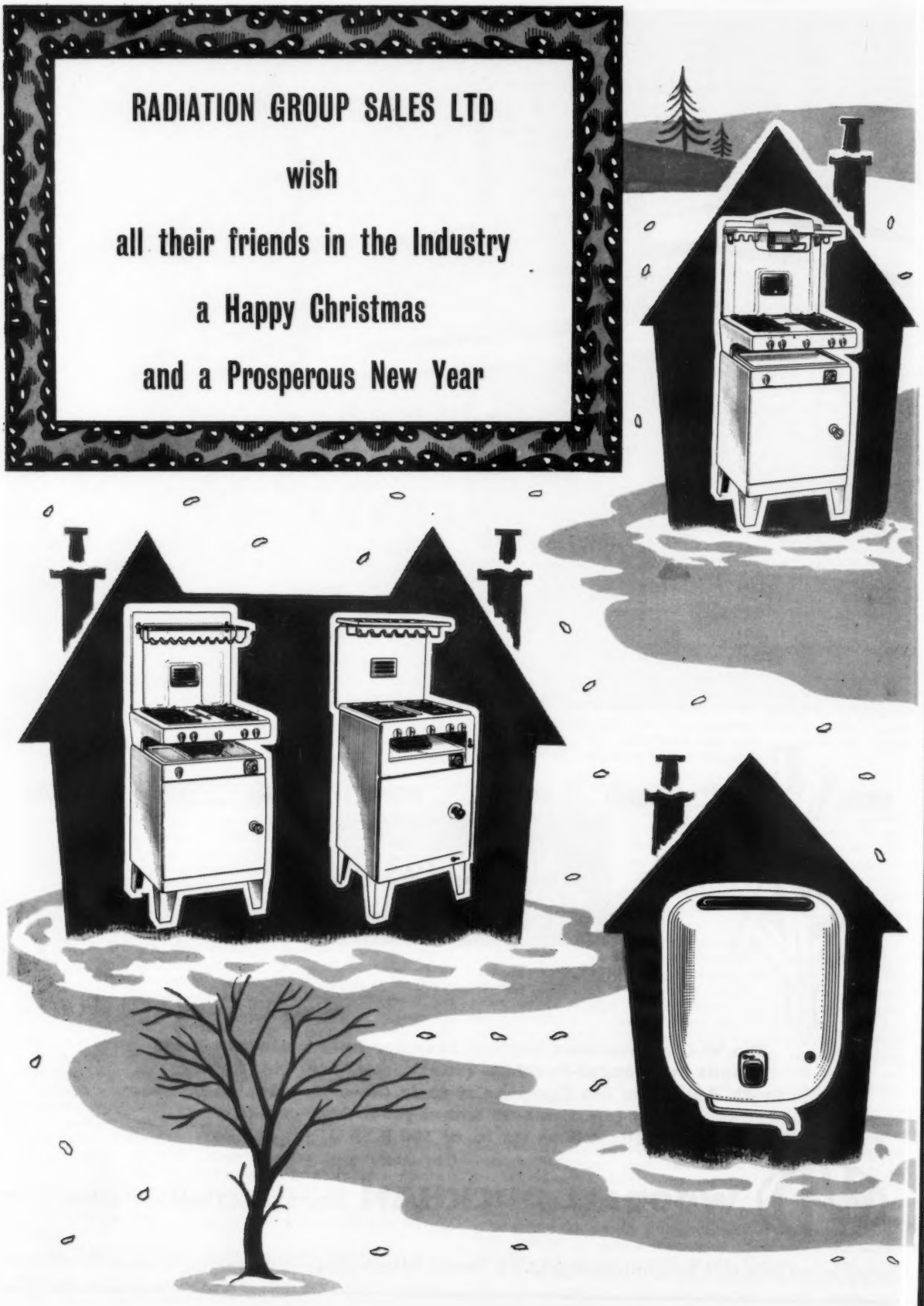

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Good Shot!

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tained. The limit of lift shown on the diagram is for gases containing little or no oxygen; that is, normal gases. For gases containing oxygen, such as those containing butane-air, the limit will move to the right (Appendix 2).

The tendency to sooting bears no apparent relationship to the flame speed of the gas and cannot, therefore, be described by the diagram. In Appendix 5 is given a curve relating the benzene and toluene contents of a gas to the fringe formed on a non-aerated flame. Sooting appears to be largely associated with this fringe. Gas containing more than approximately 1% of benzene is liable to give sooting on certain gas fires with non-aerated burners. However, gases containing large quantities of other hydrocarbons may also give rise to sooting, but there appears to be no satisfactory way at present of predicting this tendency.

The foregoing section has attempted to establish the following points:—

(1) Many of the combustion characteristics of a gas can be depicted upon a diagram, the axes of which are the Wobbe Number and the flame speed factor, *S*. The method of calculating the latter is given in Appendix 1(A). The flame speed factor is largely dependent upon the hydrogen content of the gas, which may be taken as an approximate measure of the flame speed factor.

(2) Upon the diagram can be inserted lines of equal Aeration Number. Details of the positions of these lines are given in Appendix 1(C).

(3) For appliances adjusted for G4 gas, the limits of satisfactory performance can be drawn on the diagram. These limits are discussed in Appendices 2, 3 and 4.

(4) The diagram gives no indication of the tendency to soot found with some gases on certain non-aerated appliances. This problem is further discussed in Appendix 5.

The area bounded by the limits of satisfactory performance is similar to that given by Delbourg, although the precise positions of the limits are different. The limits are similar, also, to those given by the Weaver Indexes, although the limit of light-back given on the present diagram differs from that given by Weaver's Index of light-back. Weaver's Index can be represented on the diagram and rises more steeply than the line shown.

Classification by Gas Group

The limits of satisfactory performance so far discussed have been for appliances adjusted for G4 gas—that is, for a gas having an average Wobbe Number of 730. In Britain, in order to simplify appliance design, it has been found convenient to classify gases according to their average Wobbe Numbers. At present, nearly all the gas produced can be classified in one of the following groups:—

Gas Group	Mean Wobbe No. of Group	Range of Wobbe No.
G4	730	700 to 760
G5	670	641 to 700
G6	615	591 to 640
G7	560	530 to 590

Of these groups, over 95% of the gas made in the country is in the first three. Gases outside these groups are treated as special cases. For aerated burners, modifications for the groups consist of an injector corresponding to the mean Wobbe Number and adjustment of the aeration to give cones of the correct size. For non-aerated burners, a change of burner pressure or of jet size is required.

For appliances adjusted to be satisfactory on conventional gas of one of these groups, the limits of light-back and incomplete combustion are relative to the adjustment gas. The limits found for gas group G4 can be moved relative to the adjustment gas by the methods given in Appendices 3 and 4. The lift limit, however, represents a reversion pressure of 1.8 in. w.g. on a Bray jet No. 266, size 3, or corresponding reversion pressures for other sized jets. This limit cannot move relative to the adjustment gas.

Gases have been selected from Wood[10] to have approximately the average characteristics of G5, G6 and G7 gases. The limits for satisfactory performance on these gases, obtained by the methods described in Appendices 3 and 4, are shown diagrammatically. Fig. 2 shows the limits for G4 gas for comparison, and Fig. 3 shows the limits for a G5 gas.

The prediction diagram can be of considerable use in forecasting the combustion properties of the unconventional gases

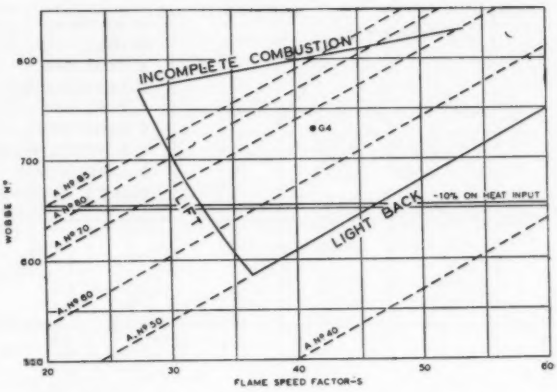

Fig. 2.—Limits of satisfactory performance on a G4 gas.

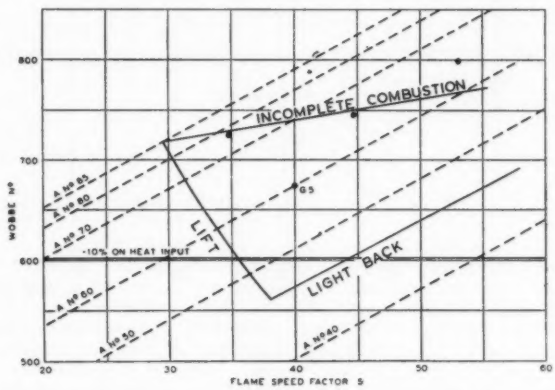

Fig. 3.—Limits of satisfactory performance on a G5 gas.

that have lately been suggested for use as town gas, and for predicting their behaviour when distributed to appliances adjusted for conventional gases.

The constituents of all the proposed gases can be divided into three groups:—

(1) Hydrogen, having a high Wobbe Number and a very high flame speed.
(2) Hydrocarbons, having high Wobbe Numbers and low flame speeds.
(3) Carbon monoxide and inerts, having low Wobbe Numbers and low flame speeds.

These three groups lie in three corners of the prediction diagram, and a preliminary idea of the performance of a gas can be obtained by considering the relative proportions of the groups it contains. Mixtures of hydrocarbons with inerts, for instance, will result in 'lifty' gases, and they may also give rise to incomplete combustion or to light-back.

It is clear, furthermore, that gases lying within the usable area must have a fairly high percentage of hydrogen. Conventional gases, produced by adding diluents to coal gas, or by adding carburetted water gas, contain 40% to 60% of hydrogen.

In Fig. 4 a prediction diagram has been plotted for most of the types of gas commonly used in the district supply and also for some of the less familiar gases that are being considered for use by the gas industry.

Considering first the more familiar constituents of town gas, it is clear that their positions on the diagram are in accord with their characteristics. Thus, coal gas has a very high aeration number and gives rise to incomplete combustion on appliances. Dilution with inerts, producer gas, or blue water gas, to the requisite calorific value, however, results usually in gases within the usable area.

Blue water gas, on the other hand, is so hard as to be unusable alone, but the addition of hydrocarbons by carburetting produces a gas that, when mixed with the diluted coal

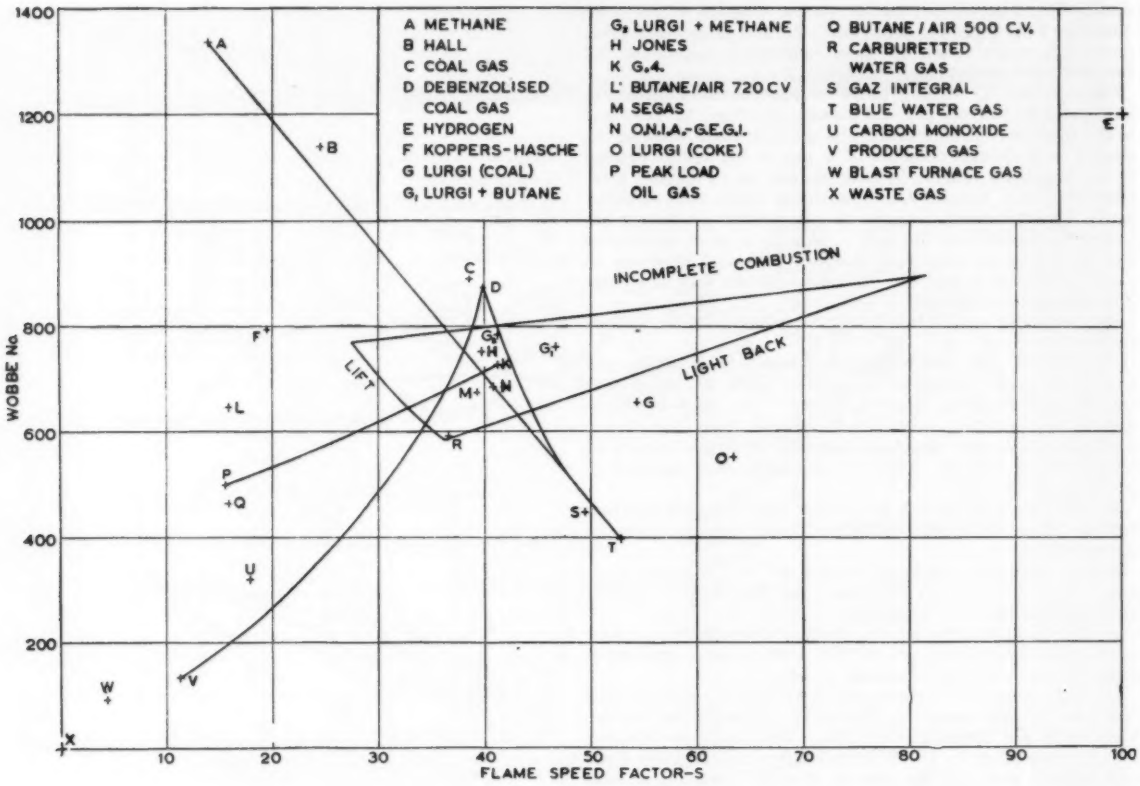

Fig. 4.—Properties of various gases.

gas, yields a satisfactory mixture. There is, however, still a tendency to light back, and it has often been found desirable to add further amounts of hydrocarbons at times when excessive amounts of carburetted water gas have been required. These gases are so familiar as to require no prediction of their behaviour. The diagram is mainly of use in considering the performance of less familiar gases. Thus, the diagram shows that apart from questions of calorific value, 'Segas' and 'Onia-Gegi' gas are both satisfactory, but gases such as Hall gas and Koppers-Hasche gas are not, though they may be usable in admixture with other gases.

Any mixture of two gases can be represented by some point on a line joining the two gases on the diagram, and the proportions of the two components in the mixture can be calculated from the Wobbe Number at this point.

The lines joining two points are slightly curved, but as an approximation they can generally be taken as straight lines. When, therefore, it is required to make a satisfactory gas from one lying outside the usable area, by mixing with another gas, the choice of the second gas must be so made that a line joining the two passes through the satisfactory zone. Having decided upon a suitable pair of gases, the points at which the line joining them cuts the limits defines the permissible proportions of each in the final mixture. In the same way, if supplies of a satisfactory output gas are to be augmented by an unsatisfactory gas (*e.g.*, a peak-load gas) the point at which the line joining them cuts a limit reveals the maximum proportion that can be tolerated.

A few examples of the use of the diagram for mixtures are shown in Fig. 5. Starting with familiar types of town gas, curve DV shows the range of mixtures of debenzolised coal gas and producer gas, and curve DT debenzolised coal gas and blue water gas. The portion of each curve that lies within the usable area indicates the proportions of the two constituents that will give a satisfactory gas.

An example of the use of the diagram for deciding how much of an unsatisfactory gas may be added to the normal supply is illustrated by curve PK, which relates to peak-load oil gas and G4 gas. The addition of too much peak-load oil gas to a normal G4 gas is known to result in flame lift. The point where curve PK cuts the lift limit may be taken as the maximum proportion of peak-load oil gas that can be tolerated in the mixture. This corresponds to about 25%, but if, as would be the case in times of peak load, the base-load gas contained large amounts of carburetted water gas, a smaller amount of peak-load oil gas could be tolerated.

One of the gases being considered for use by the gas industry is methane, obtained from mine drainage, natural gas, or from Middle East supplies. Its utilisation was considered fully in *Gas Council Research Communication GC*21. From its position on the diagram, it is clear that methane alone cannot be used in the district supply. The possible methods of using the gas are to reform it or to mix it with a suitable diluent. Examination of Fig. 5 shows that blue water gas is likely to be a suitable diluent. Mixtures of the two gases lie along the line AT in Fig. 5. The mixture, with a calorific value of 500 B.Th.U. per cu.ft. (29.3% methane, 70.7% blue water gas) has a Wobbe Number of 673 and falls within the usable area. Practical tests carried out on a mixture made up to represent this gas showed it to be satisfactory.

Gas Reforming

Reforming processes may be subdivided into steam-reforming, oxygen-reforming, and air-reforming. In the first two of these, the resultant gas is a mixture of carbon monoxide and hydrogen; in the third, these two gases are accompanied by nitrogen. The proportions of these gases will depend upon the nature of the hydrocarbon being reformed. If the hydrocarbon is C_nH_m, the proportion of hydrogen will be a maximum for m/n=maximum—that is, for the reforming of CH_4. Conversely, the proportion of hydrogen will be a minimum for m/n=minimum—that is, for the reforming of carbon.

These three types of reforming can be represented for all hydrocarbons by two curves joining the two extreme hydrocarbons, carbon and methane. One of these curves represents steam- and oxygen-reforming and the other air-reforming. These two curves have been plotted in Fig. 5. The reformed

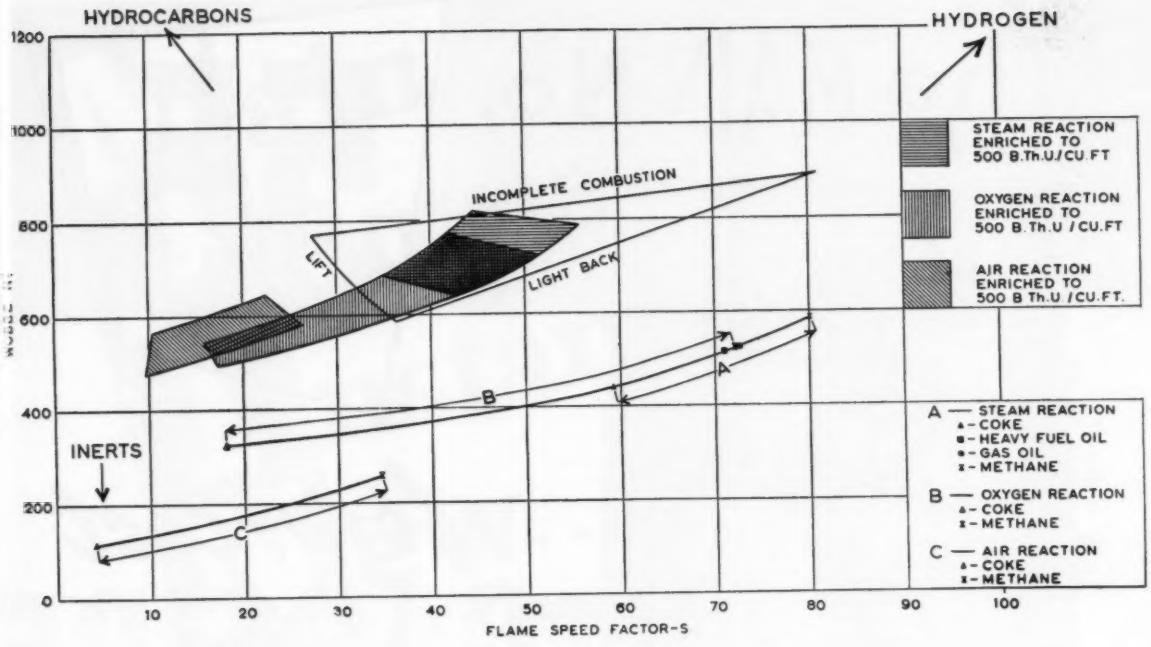

Fig. 5.—Theoretical properties of gases produced by reforming hydrocarbons.

gas will have too low a calorific value for distribution and will require enriching. This may be done either with the original hydrocarbons, or with some other hydrocarbons. Taking methane as the lowest, and butane as the highest, hydrocarbon likely to be used, one can calculate the compositions of each of these processed gases enriched to a calorific value of 500 B.Th.U. per cu.ft. When this is done, the curves representing the three processes become transposed into three areas. These are also shown in Fig. 5.

From this diagram, it is clear that steam-reformed hydrocarbons should give satisfactory gases on enrichment (which is borne out by the occurrence of the two satisfactory gases 'Segas' and 'Onia-Gegi' gas in this area). Air-reformed hydrocarbons are not satisfactory alone as they result in 'lifty' gases, while oxygen-reforming occupies an intermediate position. Oxygen-reforming of hydrocarbons with high m/n ratios should result in satisfactory gases on enrichment, but if the ratio m/n is low the resultant gas will be prone to lift.

Lurgi Process

The areas shown on the diagram are for the theoretical reformed gases. In practice, the gases will contain inerts that will displace the areas towards the origin—that is, the gas may be rather less satisfactory than indicated.

One process not dealt with so far, which is of importance, is the Lurgi process for gasifying coal or coke using oxygen under high pressure. As mentioned earlier, one method of using hydrocarbon fuels is to mix them with some suitable diluent. The difficulty in this method is that the diluent must have a high hydrogen content in order to produce a mixture within the satisfactory area of the diagram. Blue water gas is satisfactory for some hydrocarbons (*e.g.*, methane), but not for all. Lurgi gas with its high hydrogen content provides an excellent diluent for this purpose.

There is a continuous search for methods of supplying as cheaply as possible the peak demands for gas. Not only must the plant for such loads be cheap in capital cost, but it must also make little demand upon labour. Burns[15] has given methods by which the load can be met, and Grant[16] has described the addition of low-boiling hydrocarbons to the gas to increase thermal output.

The simple addition of hydrocarbons to the gas, thereby raising the calorific value, is attractive in that extra thermal output can be achieved without further demands upon storage plant. It may be difficult, however, to obtain an economic return for the extra therms thus provided, and it may be advisable to add air to the gas to bring the calorific value back to the declared value. The combustion characteristics of gases produced by these means have been examined by the method described in this paper, supplemented by laboratory examination of the gases. In the case of one type of gas, it has been possible to examine the effect of its distribution on the district.

The low-boiling hydrocarbons chosen for addition to a gas supply will depend upon their availability and the ease with which they can be stored and added to the gas. The gaseous hydrocarbons such as propane or butane can be readily added to a gas, but special storage under pressure is required for them. On the other hand, the higher-boiling hydrocarbons, petrol or benzole, are more easily stored, but have to be vaporised into the gas stream. These four hydrocarbons have been examined for their probable effect on the combustion characteristics. To increase the calorific value by 20 to 40 B.Th.U. per cu.ft., less than 2% of these materials are required, an amount insufficient to alter appreciably the flame speed of the original gas. The Wobbe Number, however, is increased and with it the Aeration Number of the gas. At the same flame speed, it is to be expected that combustion will worsen

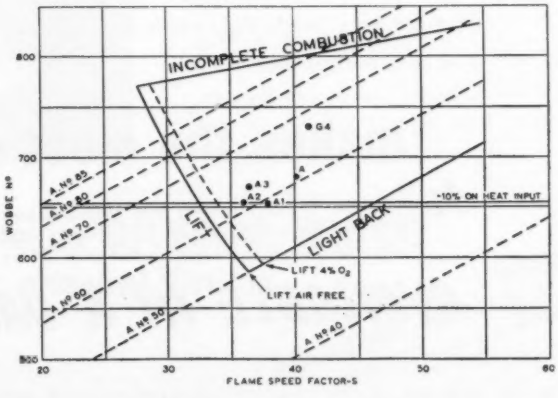

Fig. 6.—Additions of butane-air.

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with Wobbe Number. Examination of the enriched gases in the laboratory showed that combustion worsened with Wobbe Number and that, when used to enrich to the same Wobbe Number, all hydrocarbons gave similar combustion. It is probable that enrichment to a Wobbe Number of 780 to 800 by this means could be tolerated before combustion would be severely affected.

For the same increase in calorific value, benzene gives worse sooting than the other hydrocarbons, the limit to enrichment with benzene ebbing about 25 B.Th.U. per cu.ft. compared with about 50 B.Th.U. per cu.ft. for propane.

Despite the worse sooting with benzene, this hydrocarbon was readily available and was used as an additive to Fulham gas during the very cold weather of February, 1956[16]. The Wobbe Number of the gas in the first few days reached 770, but fell to 730 as more water gas was distributed. Combustion was, therefore, not unduly affected. By restricting the enrichment to 25 B.Th.U. per cu.ft., only the more sensitive gas fires showed signs of sooting on first lighting, which subsequently burnt off. Some sink water heaters produced puffs of soot on ignition, but no soot deposition was found in the heat exchangers of these heaters, and no serious complaint of sooting on any appliance was received from the district.

To avoid the difficulty associated with distributing gas of higher calorific value than the declared value, it is possible to add a diluent with the hydrocarbon in order to increase the output under peak-load conditions. Of the possible diluents, air is, of course, the most readily available. Should the conditions require it, it is still possible to increase the calorific value in order to increase the thermal output.

Butane-Air Mixtures

Butane-air of 500 B.Th.U. per cu.ft. has a specific gravity of 1.156. The addition of this gas to normal town gas of 500 B.Th.U. per cu.ft. will, therefore, result in a higher specific gravity and lower Wobbe Number. As butane-air has a low flame speed, an equally important effect will be the reduced flame speed of the mixed gas, causing, with the lower Wobbe Number, an increased tendency to lift. These effects are illustrated by the results of calculations and experiments on the addition of butane-air to gas from Station A. The gas produced at full output consists of 50% coal gas diluted with blue water gas and 50% of carburetted water gas having the following composition:—

	Gas A
CO_2	3.9
O_2	0.8
C_nH_m	4.5
CO	18.7
H_2	46.7
CH_4	16.1
C_2H_6	1.3
Calorific value	500
N_2	8.0
	B.Th.U. per cu.ft.
Specific gravity	0.54
Wobbe Number	680

This gas is used in an area in which the appliances are set for G4 gas (mean Wobbe No. 730). The lowest acceptable Wobbe Number is therefore 655 (*i.e.*, 10% below the mean adjustment gas). This Wobbe Number gas can be provided by means of a mixture of 90.3% of Gas A with 9.7% of butane-air of 500 B.Th.U. per cu.ft. (Gas A1), or, alternatively, it can be obtained at a calorific value of 520 B.Th.U. per cu.ft. of the mixed gas by means of 84.6% of Gas A with 15.4% of butane-air of 625 B.Th.U. per cu.ft. (Gas A2). These two gases, together with a third mixed gas of 520 B.Th.U. per cu.ft., but of Wobbe Number 670 (Gas A3), have been examined for their combustion characteristics both theoretically and experimentally. The positions of the gases on the prediction diagram are shown in Fig. 6, and the experimental results are shown in Table 2.

It will be seen that, broadly, the predictions are verified by the experimental results. All these gases show a greater tendency to lift than does usual G4 gas, but, other than Gas A2, their measured reversion pressures are within the limit of 1.8 in. w.g. reversion pressure on jet 3. It is recommended that, if these gases are distributed, a test for reversion pressure should be made. Provided that the Wobbe Number is maintained to not less than 10% below the average value for the area, and the reversion pressure does not fall below 1.8 in. w.g. on jet 3, difficulties should not arise on the district.

It was subsequently realised that butane from refineries having cracking plant contains a high proportion of unsaturated hydrocarbons. Calculations showed that the addition of unsaturated hydrocarbons might increase slightly the flame speed of the mixtures. Examination of gases A1 and A3, however, made up with a sample of butane containing 46% of unsaturated hydrocarbons, showed that the effect was small. The Aeration Numbers of the gases were reduced by 2 to 4 units, while the reversion pressures were almost unaltered. These gases were also examined for sooting on a sensitive gas fire, in case the unsaturated hydrocarbons produced soot. No sooting was observed.

Gas A contains 50% of carburetted water gas. As will be seen from Fig. 4, carburetted water gas is close to the lift limit. Gases containing smaller proportions of carburetted water gas than gas A can have greater additions of butane-air before the limit of lift is reached. On the other hand, it seems probable that, with gases in groups other than G4, rather less butane-air can be added before the limit of lift is reached.

Prediction of Combustion Characteristics

It has been shown that the combustion characteristics of a gas can be predicted reasonably accurately from the analysis of the gas. The method depends upon a calculated flame speed of the gas, and for this reason cannot be considered entirely satisfactory. Nevertheless, the relative properties of gases are quickly envisaged by the prediction diagram, and this enables a sorting into satisfactory, unsatisfactory and borderline gases to be made readily. The mixing of other gases with those that are unsatisfactory or borderline, in order to improve performance, can also readily be seen.

It is suggested, therefore, that, when a novel gas is considered for the town gas supply, its evaluation should be along the following lines:—

(1) The calculation of the combustion characteristics by the method given. If these characteristics are unsatisfactory or borderline, the diagram will help in deciding how they may be improved.

(2) The testing in the laboratory of a small sample of the gas that will be distributed; usually 10 cu.ft. of the gas made up with gases from cylinders is sufficient for this purpose.

TABLE 2.—ADDITIONS OF BUTANE—AIR

Gas	Calorific Value (B.Th.U. per cu. ft.)	Specific Gravity	Wobbe No.	S	A. No.		Reversion Pressure—Jet 3 (in w.g.)		Combustion on a Boiling-burner (CO/CO_2)	Volume Output Increase (per cent.)	Thermal Output Increase (per cent.)
					Expected	Found	Expected	Found			
A	500	0.54	680	40.1	60	66	2.4	2.3	0.004	0	0
A1	500	0.59	655	37.9	60	63	2.1	1.8	—	11	11
A2	520	0.63	655	36.4	60	65	1.9	1.7	—	18	22
A3	520	0.60	670	36.0	65	65	2.0	1.9	0.004	11	15
G4	500	0.47	730	41.4	—	67	—	2.8	0.007	—	—

(3) The testing of particular appliances on larger samples of the gas, the appliances being chosen to be sensitive to those characteristics indicated by the previous calculations and testing as likely to give rise to difficulty.

In this way, a complete picture of the effect on the district can be built up.

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DISCUSSION

Mr. J. E. Davis (South Eastern Gas Board) emphasised that one of the subjects of enquiry had been the identification of a factor other than the Wobbe Index which was needed to describe adequately the combustion characteristics of a gas. The Delbourg diagram, he said, gave a broad hint by plotting Wobbe Index against the 'combustion potential,' calculated from a somewhat arbitrary formula. On the diagram between these ordinates appeared a triangle, the quantity to be plotted on the abscissa being flame speed factor or, alternatively, hydrogen content.

If, continued Mr. Davis, the gas quality remained within the triangle, then no difficulty from lift, light-back or incomplete combustion need be expected, but if gas composition overstepped the boundary, then the risk of trouble existed not with all appliances but with some. Finally, he concluded, it had not been possible completely to predict combustion characteristics from a knowledge of the composition of the gas. But now it was so or very nearly so, and Figs. 4 and 5 of the paper by Messrs. Prigg and Gilbert showed some applications of this new ability. In looking at them it must be remembered that the standard gas to which existing appliances were assumed to be adjusted was a G4 gas, shown in Fig. 9 as 'X.' If they had such appliances on their district they would be unwise to go outside the triangle, but there were still many possibilities of making an acceptable gas whose properties lay well within the boundaries. Fig. 10 showed in a striking way how this new and clarifying concept might be employed to solve a production problem. The problem was to devise an appropriate system for the gasification of hydrocarbons by reforming. Clearly a process based upon reaction with air alone was going to give an unacceptable product. One based on oxygen alone might or might not give a suitable gas. The steam reaction alone would give a gas of appropriate characteristics, and fortunately the areas of the endothermic steam reaction and the exothermic oxygen reaction overlapped, providing a substantial area within which to look for a thermally balanced reaction giving a wholly acceptable gas.

Mr. A. R. Bennett (Research Manager, Radiation Ltd.) remarked that a year ago he pointed out that in the case of cooker hotplate and gas-fire burners generally it was safe to say that appliances could be operated on the average at at least 10% higher efficiency than now generally obtained if designed and adjusted for a gas supply of constant quality.

In this connection it might well be that the present authors' work would point the way to improvements in mixing technique so that some of the more extreme variations in quality could be avoided and in due course advantage could be taken of the more precise design basis which this would make possible. He felt sure that if more attention was given to these matters by those responsible for gas manufacture the way would be opened for progress towards greater user satisfaction than was possible so long as gas of widely varying quality had to be utilised.

French Point of View

M. J. Bruhe, reading a contribution on behalf of **M. Bolzinger,** Directeur des Recherches du Gas de France, emphasised that the French studies involved the action of the supply pressure to the appliances. As the pressure increased, the calorific flow increased as the square root of the pressure; the 'lift line' moved quickly to the right, the 'incomplete combustion line' moved towards the bottom of the diagram, and the 'light back time' was also a little lower. It was then necessary to take into account the possible pressure changes of the system which were finally reducing the interchangeability zone.

The French points of view upon this question dealing with interchangeability of gas for domestic and industrial appliances under varying pressure had been stated in a report by M. Bolzinger and M. Caudeville to the International Gas Union meeting in New York in 1955, and the prediction of the characteristics of different suitable gas mixtures had also been studied.

It has been admitted in France that it was necessary seriously to reduce the limits in which the gas could vary. The Wobbe number must not vary more than $\pm 5\%$ for domestic and more than $\pm 3\%$ for industrial consumers. The blue cone height must also have strictly limited variations.

The paper by Mr. Gilbert and Mr. Prigg dealt with conventional town gas (Wobbe number 700, calorific value of about 500 B.Th.U. per cu.ft.). Five groups of gases were considered with the five corresponding interchangeability zones.

M. Delbourg had determined the zone corresponding to any gas in these groups by showing that, as a logarithmic diagram, the zone had the same shape and the same sizing around the spot representing the gas for which the appliance had been adjusted. This process seemed to be commendably accurate.

The presence in France of more and more complex gas mixtures, and of gas of high calorific value had shown that the adjustment indices chosen ought to be corrected when the gas contained important contents of carbon monoxide, carbon dioxide or oxygen on the one hand, or very rich hydrocarbons on the other hand. M. Delbourg had presented this point in a report to the French Gas Association in 1956. He had demonstrated that as one moved away from the usual gases, one must use a corrected Wobbe number, and correct the second variable —'combustion potential' or 'flame space.'

Mr. E. A. K. Patrick (Watson House) directed attention to interchangeability as it affected the industrial field. The majority of industrial gas appliances, he said, were at least as tolerant as domestic appliances, and it was felt that gases kept within the appropriate domestic appliance limits would give no trouble in these industrial appliances. Nevertheless, three circumstances could be foreseen in which industrial gas equipment might require working to closer limits.

The first of these was the case of a furnace operating at a fixed temperature and provided with a constant pressure governor but no thermostat. There were many such appliances to which the application of thermostatic control was for one reason or another not easy. A variation of 10% in Wobbe Number could produce an appreciable change in temperature in such an appliance.

Similarly thermostats were almost impossible to apply to radiant heating processes, and spoilt work, of considerable value, might result.

The second case may be named 'precision flame heating.' The principal example of this field was the glass working burner used in large numbers in the manufacture of electric light bulbs, electronic valves, ampoules *etc.* There was good reason to believe that Wobbe number was the principal controlling factor in this application, although actual flame length

could affect the chemical action of the flame upon the glass. A closer degree of control over Wobbe number was definitely required here, and more than one Board was experimenting with the provision of automatic control of Wobbe number on the consumer's premises with considerable indication of success.

The third class was that in which the chemical composition of the products of combustion was required to be maintained within specified limits; in other words, the provision of controlled atmospheres. This, of course, was quite a different matter from the previous cases, in which heat release was the principal consideration. The problem was to ensure that the air supplied for combustion was varied to accord with changes in the theoretical air requirement of the gas .

This was being studied, and preliminary indications were that, while none of the suggested new gases which was likely to be satisfactory for use with domestic appliances would give rise to appreciably greater variations in atmosphere composition than gases at present being distributed; for both classes of gas closer limits would need to be drawn on the interchangeability diagram if controlled atmosphere plants were to be unaffected by change of gas.

Local Gas Quality Control

It might be possible to devise appropriate control systems for use on the premises of consumers using town gas for controlled atmosphere generation. Such provision, however, inevitably increased the effective price of gas and impaired the competitive position. The amount of gas sold for this purpose was not large in relation to total industrial gas sales, but the type of work treated in controlled atmosphere furnaces was usually intrinsically costly, and the gas industry became very unpopular if a load was spoiled.

It was not gas composition, but unheralded changes in gas composition which made life difficult, and these changes would arise more frequently as integration of distribution systems proceeded. He hoped that the authors would one day be able to present a revised diagram showing the limits for precision flame and controlled atmosphere applications.

Mr. G. H. Fuidge (Chief Physicist, South Eastern Gas Board) commented on the Delbourg diagram, and said many representatives on the I.G.U. Committee reported on its usefulness. It was clear in such a complex problem as the interchangeability of gases it was easier to use a diagram than to apply a number of rather complex formulæ as put forward by Weaver. The Delbourg diagram was, of course, related to Continental appliances, and the shapes of the curves limiting the area of interchangeability seemed to him rather difficult to understand. The diagram produced by the authors not only had the advantage of being applicable to British appliances, but the limits of the area of interchangeability seemed to be more soundly based fundamentally than those in the Delbourg curves.

He would like to add his congratulations to the authors on the production of the diagrams Figs. 9 and 10 in the paper, which should be of great value to production engineers and chemists contemplating new methods of gas manufacture. Fig. 9 showed how gases outside the area of interchangeability could be brought inside by mixing with other suitable gases, and Fig. 10 showed clearly what could and could not be done to produce an acceptable gas by the reforming of hydrocarbons.

Dr. J. Shack (Fuel Chemist, West Midlands Board) said one small outlying works suffered from occasional but violent peak load troubles, and the use of a butane-producer gas mixture had been considered. A certain amount of time and money had been spent on an experimental outfit which showed that an addition of 20% of this mixture resulted in 'lifting' of the flames. Had this paper been available at the time a short calculation would have shown that this particular town gas could not tolerate more than 15-18% of the butane mixture; as this was far below the amount required, experiments did not serve any useful purpose.

Mr. J. Foxton (South Western Gas Board) said there could be no doubt that with the increasing use of oil to meet demands for gas, both as C.W.G. and oil gas, the hydrocarbon content of town gas would show an increase. In low pressure gas distribution systems this was of little consequence, but in high pressure mains it could result in loss of calorific value, owing to deposition of liquid hydrocarbons.

With losses of 20 to 30 B.Th.U. per cu.ft., which were possible in high pressure systems, and where large volumes of hydrocarbon-rich oil gas might be employed, the Wobbe number of the gas might be lowered by 50 at least, and this would be sufficient to move the gas outside the desirable range. In effect, it seemed that the gas was satisfactory at the manufacturing station and might be unsatisfactory at the consumer's end.

A study of the vapour pressures of the condensible hydrocarbons present in the gas would not be of much assistance in predicting the loss. It was suggested that in compression a loss of calorific value would occur if the critical pressure of the lowest vapour phase constituents was reached. These constituents of the gas would then be deposited as a liquid and would act as a scrubbing medium, removing constituents of higher vapour pressure which would under normal circumstances remain in the gas.

There would appear to be a need for a study of the behaviour of hydrocarbon gases when compressed, and also methods of compressing gases containing condensible vapours. With reciprocating compressors, pressures in the cylinder at the end of the stroke must be in excess of the mains pressure, and it might well be that at this point a hydrocarbon spray was carried forward into the gas main.

The French gas industry had set up a centre for the study of the compression and partial condensation of gases when used for long-distance supply. In this country the problem has not yet been faced. If such advances in the study of the behaviour of gases, as outlined by the authors, were to be effectively applied, serious consideration would have to be given to the problem he had mentioned.

Dr. G. W. Culshaw (Stoves Ltd.) said that in the paper experimental and theoretical conclusions had been indiscriminately mixed and he was uncertain in some cases as to whether the authors had derived certain conclusions from theory or from experiment. Fig. 4 of the paper was vital in that it presented the basic conclusions of the authors, and hence criticism of this diagram would be criticism of the authors' main thesis. The scatter of experimental points about the lines of equal aeration number seemed quite serious and was actually discussed by the authors. This did not, however, stop them from the drawing of a series of parallel straight lines to represent these points and even, in Appendix 1 (c), giving mathematical equations (apparently correct to 1 part in 690) for these lines.

Lines of Equal Aeration

Again these lines of equal aeration number were used subsequently to advance various hypotheses, for example, on page 41 of the paper in the discussion of Fig. 17. Because of the difference in slope of the aeration number lines and the lines of equal CO/CO_2 ratio, it was concluded that both Wobbe number and aeration number influenced combustion. As mentioned by the authors, Fuidge and Dewhurst claimed that only the Wobbe number influenced combustion. However, if the 0.020 CO/CO_2 and the 0.088 CO/CO_2 lines were considered, the best line to fit the experimental points in both these cases would probably be one parallel to the aeration number lines. This would mean, contrary to the findings of the authors and of Fuidge and Dewhurst, that only the aeration number affected combustion.

These lines of equal aeration number seemed somewhat indefinite, and the lines of constant CO/CO_2 ratio had apparently not necessarily been drawn through the points in the best manner. The significance of these lines of equal CO/CO_2 ratio, however, was important, because, although it was not clear at first sight, the line of 0.020 CO/CO_2 ratio was actually the top line of the zone of good combustion in the basic Fig. 4. If they had any doubt about that line, they therefore had doubt about the top limit of this zone, and he maintained that from the derivation and from the doubt about Fig. 17, that top boundary was very doubtful indeed.

Also, the bottom boundary was the line of constant aeration number in the case of G4 gas of 50 A.T.B., and these points had a very serious scatter about those lines and that the lower boundary must be indefinite.

The third boundary of the diagram, the 'lift' line, was admitted by the authors to be somewhat arbitrary. There was, apparently, no definite boundary for this, and they had established one. Suppose they accepted this in the case of the G4 gas, which was the gas with which the authors worked.

For the other gas groups, they are told that the equation for conversion was

$$\frac{W}{W_a} - 0.132\,\frac{S}{S_a} = 0.968,$$

an equation supposed to be accurate to one part in 968. The derivation of these constants was not given in any detail, however. This equation was checked not for the lift line but for the incomplete combustion line as detailed in Tables 15 and 16; the points were shown graphically, in Figs. 6 and 7 respectively.

It was unfortunate however that the point for gas E.17 was omitted from Fig. 6 and the point for gas E.14 was omitted from Fig. 7. If these points were inserted in the graphs not only did they tend to alter the slope of the lines of incomplete combustion but they were found to lie a good way outside the lift limit. Here the flames should have been unstable with these gases and yet the authors managed somehow to carry out combustion tests. This tended to cast doubt on the validity of the 'lift' limit to the zone for good performance.

They had now considered the three lines which really amounted to the 'meat' in the paper, and it seemed that these three lines were all somewhat suspect. Therefore, as a logical conclusion one would say that the paper was suspect.

In their conclusions at the end of the paper, the authors stated that, first, they should calculate the combustion characteristics and see whether they fitted into the diagram, that, secondly, they should test a small sample, and that, thirdly, they should test a small sample of appliances. He felt that they could well cut out the first of those proceedings.

Mr. L. T. Minchin (Consultant), said he had been doing this work nearly 20 years ago under the inspiration of Mr. Masterman, then Director at Watson House, a man whose foresight and imagination had not been adequately recognised by the industry. Working in the days before the war he had designed an aeration test burner, first the A model, and then, later on, the B model, which remedied many of the defects which had become apparent in the first model.

It had been a great grief to him to find Mr. Gilbert and Mr. Prigg indulging in the ingenious formula of A = 1.6B + 8, which would make many of our friends abroad who read the paper scratch their heads in despair and think that it had something to do with rods, poles and perches or driving on the left-hand side of the road.

Graphical Method

The graphical method was of great advantage, although he was not convinced that we should not get nearly as good results by saying that the Wobbe number must lie between so much and so much and that the maximum flame speed must lie between two other limits. It was true that that gave a rectangle instead of a triangle on the diagram, but as Dr. Culshaw had pointed out passionately, the exact shape of the lines and curves was a matter for considerable dispute, and no one would suggest that they were more than indications. You could not possibly define by a hard and fast rule the exact shape of the line and the exact point at which the gas ceased to be suitable for use in appliances.

'If we are to have this graphical method—I agree that it is probably a very good idea in practice—I am sorry that the flame speed factor "S" of Weaver, which is rather complicated and completely arbitrary and empirical, should have been adopted,' he continued. 'I believe that the Weaver formula is complicated to work out. It is given in Appendix I as a purely empirical formula based on a kind of mathematical sausage machine.

Accuracy of 'S'

'If you look at Fig. 2, which shows the Weaver "S" figure against actual measurement of flame speed, you find agreement quite good in the central bunch, but as soon as you get far from the central bunch, such points as shown—there are two or three—are wide of the mark. Moreover, the curve does not necessarily go through the origin, as shown, though it is nice to try to make it do so. The gas which is not combustible because the combustible content is too low would not necessarily have a flame speed factor "S" on the "O," though, admittedly, it would be low.

'I suggest that it would be much better to use the measured flame speeds of the known pure gases and combine them by the Payman and Wheeler flame speed law.

'It is very important now that we have a new standard. There has been difficulty in getting the aeration test burner made to a standard pattern so that all models would give the same results. Although Watson House serves a valuable purpose as a calibration centre for the ones being made commercially, it is very important, because it is an arbitrary standard. Their whole usefulness depends upon all the A.T.B.'s in existence giving the same results.

'The same situation will arise with the tee-jet which the authors are to use. I hope that there is in relation to the tee-jet somewhere enshrined in Watson House, to be touched only once a year, a supreme standard sample from which special standards can be calibrated for distribution throughout the country and the world so that we shall get reliable comparable results of flame lift.'

Dr. J. R. Dewhurst (Senior Physical Chemist, South Eastern Gas Board) criticised the authors concerning their reference to plus or minus 10% of the Wobbe number. The limits might be correct for combustion, but for effectiveness of the appliance he was sure they were too wide. If they dropped the Wobbe number by 10% a number of appliances would give a service which was not as good as that which ought to be acceptable. Such gases would be satisfactory from the combustion point of view but they should be distributed only in an emergency and not as a normal procedure. In the South Eastern Gas Board's area the procedure was to increase the Wobbe number by enrichment—extra carburation or reduced dilution—if the Wobbe number would fall below 700 because of having to meet a large demand.

They had been looking at the question of using liquid petroleum gases. One of the easiest ways seemed to be to enrich the gas to 600 B.Th.U./cu.ft. In other words, that gave a calorific value of 600, where they had enrichment to 600 B.Th.U./cu.ft. instead of 500 B.Th.U./cu.ft. If that was done one might not have to alter the appliances because the Wobbe number could be kept within the limits 700-760. That could not be done with an ordinary G.4 gas, but carburetted water gas or, better, blue water gas enriched with propane to 700 C.V. gave a point on the diagram which was nicely inside the limits. The aeration number from the diagram was 85 in one case and 84 in the other. They made up some of these gases and got an aeration number of 86 in one case and 85 in the other, but he suspected that there was considerable coincidence about that. When they tested these gases for combustion on a cooker the combustion was very good and the CO/CO_2 ratio was below 0.01. The tendency to give soot was small.

Mr. P. S. Murthy, Midlands Research Station, said, 'I wish to congratulate the authors on preparing such an interesting paper. The following is of particular interest to India where gas of low calorific value is more easily available than gas of high calorific value.'

Referring to Fig. 9, page 20, of the paper, the blue water gas was hard to use because it was so far inside the 'light back' region. But the velocity of the blue water gas through the burner nozzle could be raised sufficiently high by increasing the gas supply pressure and the air inspiration cut down, by adjusting the air shutters, such that the flame was stable at the burner tip. A few burners which were originally designed for town gas of 450-500 B.Th.U. had been used for domestic purposes on wood producer gas of about 150 B.Th.U. by having gas supply at 9 in. W.G. at the burner point. The flame was long but not inconvenient. 'The circumstances did not enable us to thoroughly investigate the performance of the burner in that condition.' He added: 'Do the authors consider that gases of low calorific value and high flame speeds can be successfully used by modifying the burner nozzle and supply gas pressure? This is of particular interest in a country where coke oven gas is not in abundant supply and some alternative system of fuel supply in the medium of gas has to be supplied. The cost of distributing the gas at higher pressure has to be compared against the cost of enrichment of gas by hydrocarbon synthesis. The burner suitable for the supplied gas can be easily introduced into the market.'

REFRACTORIES

A REVIEW OF THE 47TH REPORT OF THE I.G.E. JOINT REFRACTORIES COMMITTEE

ONLY three of the numerous sections of the outsized 47th Report of the Joint Refractories Committee, presented to the Institution's 22nd Autumn Research Meeting on November 20, can be regarded as purely theoretical or nearly so; the rest are most encouragingly practical.

Prof. A. L. Roberts, the Chairman of the Committee, presented the seventh of the reports of the lengthy investigation of the clay-quality system represented in our supplies of silica refractories. This year's work concerns the action of alkali on silica at high temperatures. Alkalis have long been known to favour the development of silica in the desired form, tridymite. The present work confirmed this, and that the development passes through the intermediate form, cristobalite. But the interesting thing was that it explained 'a fact which has puzzled the refractories man for a long time.' Both these forms are crystalline. 'Why, in defiance of physical chemistry' can they both co-exist in commercial materials? Not only, however, is it demonstrated that they do exist together but that 'there is *a little stranger* among them in the shape of an intermediate form, non-crystalline in type' which in turn produces tridymite. The work is 'quite academic but it does seem to be another step forward towards knowing just how to get what we need in silica and siliceous refractories, although that ideal is perhaps a long way off.' Prof. Roberts feels that a picture is beginning to emerge of the relationships between the various forms of quartz which is at least beginning to show something of a pattern. No doubt he and his fellow research workers will see the pattern first.

Then we have the extension of last year's work on Young's modulus in silica bricks at high temperatures to alumina-silicate refractories. The increases are only small with these materials, but there are qualifications to this statement which must be read in detail. The practical implications are not very clear except, as Mr. Beale suggested, the emphasis on the importance of using grog in an alumino-silicate mixes with thermal characteristics similar to those of the main material or at least grog of fine grain, a conclusion with which Dr. Rigby agreed.

The sonic spalling test seems to us to be even further from practical application. It is claimed to be 'a new attempt to measure thermal shock resistance.' Mr. Gaskill thought that it indicated interesting possibilities in the direction of determining the critical rate of heating of refractories. It suffers from the disability, admitted by Dr. Rigby, that 'there is no method at the moment of interpreting the rate of heating with one size of specimen into a safe rate of heating for a different size of specimen' (even of the same material?). 'That is all for the future.'

Scurfing

Of the practical papers, that describing the temperature surveys of two types of continuous vertical retorts during the scurfing period excited the greatest interest. The two previous surveys were conducted in retorts in normal working; this third and last paper relates solely to the scurfing period—a period when the retorts are in an abnormal condition. It is not, of course, surprising that in spite of checking the temperatures of the setting by damper manipulation and in spite of the now generally adopted method of downward scurfing, during scurfing the temperatures of the top of the retort rises to about 300°C. above the average working temperatures. But Mr. Gaskill is still not satisfied that this operation receives the necessary attention of the technical retort house control. It is still sometimes left to semi-skilled labour. Temperatures are too often allowed to rise far above those here recorded, by rushing the operation too quickly, or at the other extreme retorts may be allowed to reach undesirably low temperatures. Mr. Gaskill emphasised the value of controlled steam admission, preferably at the base of the retort, as a means of controlling temperatures in the retort during scurfing.

It is undoubtedly most important to maintain an effective control of air admission during scurfing because there is always the risk of very high temperatures, however localised, arising from rapid combustion of the scurf at any broken edge. Mr. Mead emphasised the importance, by no means universally appreciated, of reading the temperatures in the flues of scurfing retorts *every* day just as on working retorts. All this could be summed up in the statement that scurfing retorts require more rather than less supervision.

It is curious that the point noted in the report was that relating to the descent of coke in the retort after filling for re-starting. Temperature readings were taken to indicate that it descended faster in the middle than at the ends of the major axis, and it was suggested that this might explain difficulties sometimes experienced in starting up after scurfing. Mr. Gaskill was doubtful whether these conclusions were justified by the evidence and that this phenomenon might even be an advantage, since 'the cone of carbonisation is established by this natural movement of the coke'—and finally, that difficulty in re-starting—'provided, of course, that the inner surface of the retort is in reasonable condition, is usually associated with the ability of the extractor to control loose coke.'

The Refractoriness-under-Load Tests

It has always been disappointing that this very practical test has not been developed to such a level of reliability (reproducibility) as to permit of its inclusion in the standard specifications. The very satisfactory advance in this direction reported this year covers the work done by the *ad hoc* Sub-Committee of the B.C.R.A. under the chairmanship of Dr. Cross, who resigned from that position some time ago. His place has been taken by Mr. Oliver, whose experience in the control of manufacture of refractories is a guarantee that the work will be pushed through with continued vigour. The new Chairman noted that as a result of three years' work, specific modifications of the present standard test have been recommended. Before these can be accepted as standard, however, they are to be tried in as wide a range of refractories testing laboratories as possible. The necessary information is to be disseminated as widely as possible so that the maximum of practical experience with the application of the new recommendations may be obtained. It is hoped that though the modifications will increase the cost of the test, both in equipment and time, their adoption will lead to the perfection of this most desirable criterion of the reliability of refractory materials under working conditions.

Permeability and Porosity

Mr. Laming has pushed this work into the higher temperatures—'the important factor in relation to flaking is the permeability at the working temperature.' Apparatus for testing this property up to 1,000°C. is described in the paper. At the same time practical trials are in progress at three gasworks where British and foreign bricks have been built into continuous vertical retorts in operation. So far the foreign materials 'of low permeability and porosity' have shown 'considerably greater resistance to flaking than the normal British brick.' Mr. Beale notes 'that though the permeability of all unused bricks rises with temperature, the amount by which the values rise for the lower permeable bricks is about equal, regardless of type, and therefore the degree to which permeability affects the ultimate durability of these products should be similar.' Dr. Rigby's remark should also be noted: 'If there is a relationship between permeability and flaking resistance, quite obviously this test is going to assume great practical significance.'

Miscellaneous Field Work

Last (Dr. Rigby put it first!) we come to the short section containing news of extremely interesting observations which are being made in the field."

The four benches of continuous verticals built 'at a gasworks in the West Midlands Area' (anyone who has followed published literature knows the reference is to the new plant at

Etruria) with a different type of refractory in each, have been kept as promised under constant observation. Three benches are built in silica and one in siliceous material. The measured expansions are of great interest; Mr. Gaskill doubts at least one of the inferences. With regard to the siliceous bench, his experience was that even when lateral expansion adds up to the closing of expansion joints it was often found, on subsequent examination when the setting was let down, that some proportion of these spaces still remained open. Further observations of flaking, which has occurred to some extent particularly at the usual levels in the silica retorts, will be awaited with interest.

But perhaps the most interesting item in this section of the report is that describing the tests with iron-spotted silica goods. Operators of continuous verticals, intermittent verticals, horizontals and coke ovens have all joined in this very fine piece of co-operative investigation.

Dr. Rigby said he had been told, just prior to his presentation of this report, that the 47th report ran to 30,000 words. He thought he was meant to infer that nobody could be expected to read it. We can assure him, however, that at least those engaged in the manufacture and utilisation of refractory materials will have already read nearly all of it with the very closest attention, and that the work of the Joint Refractories Committee is of the very highest value to the gas industry.

'Nickel Plating for Engineers'

WITH the aim of promoting a better understanding between the designer and the planner, the production engineer and the electro-plater, the Mond Nickel Co., Ltd., have published a booklet entitled 'Nickel Plating for Engineers.' It is the Company's hope that the publication, by making possible proper attention to details of shape and size of the article and the duty it is expected to perform in service, will ensure that the process is applied with maximum efficiency and economy, giving lasting and satisfactory results.

No attempt has been made to cover plating procedures in great detail, but practices have been dealt with insofar as they affect the properties of the resultant deposits. The text includes a description of surface preparation in general and for zinc-base alloys, aluminium, and nickel-chromium-iron alloys in particular. Commonly used solutions, relevant plating procedures to maintain high quality work, plant required, mechanical properties of deposits, and methods of testing deposits are all dealt with in a highly compressed text. A good deal of information is given in the form of graphs or tables for quick reference.

New British Standard for Low Presssure Central Heating

THE British Standard code of practice for central heating by low pressure hot water (CP. 341.300-307:1956) was prepared on behalf of the Council for Codes of Practice of the British Standards Institution by a joint committee convened by the Institution of Mechanical Engineers and the Institution of Heating and Ventilating Engineers. It deals with the work involved in the general planning, designing and installation of a system of central heating by low pressure hot water (i.e., where the system is open to the atmosphere at one or more points) and utilising appliances such as column radiators, convectors, surface panels, unit heaters, and pipe coils. Its recommendations are applicable to central heating installations suitable for the whole range of buildings—private residences, multi-storey flats and office buildings, schools, and general industrial premises. The recommendations assume that the design of such installations will be entrusted to qualified engineers and that the execution of the work will be carried out under expert supervision.

The head-code deals with the general aspects of central heating by low pressure hot water; seven sub-codes cover in detail the subjects indicated by their titles. Each sub-code includes a list of the British Standards relevant to its subject. Titles of the sub-codes are—boilers and calorifiers, storage vessels, pipework, fittings, valves, taps, and cocks, appliances (column radiators, surface panel, convectors), unit heaters, power driven circulating pumps for low pressure hot water heating installations, and thermal insulation.

The committee, while basing their design recommendations on present accepted practice, have drawn attention to the work undertaken by a committee appointed by the Minister of Works to enquire into the need for adjustment of the basic outside design temperature for heating installations. The findings of this committee will be published by H.M.S.O. as Post War Building Study No. 33. The committee have also maintained close liaison with the Institution of Heating and Ventilating Engineers and have used in the code information and tabulated data published in the *Institution Guide to Current Practice*.

Efficiency Through Contentment

CLOSER attention to psychological incentives and discouragements might go far to increase industrial efficiency and thus help to overcome economic problems, suggests Dr. H. G. Maule in an article in the October issue of *Occupational Psychology*, journal of the National Institute of Industrial Psychology. The shortage of labour since the war, he says, has led to the examination of incentives and, more recently, to renewed interest in work study. But the question of social and psychological aspects of work has hardly been touched by the work study engineer, who leaves unanswered the question: What makes people work well?

Aspects of industrial training are discussed in two articles in the issue. One, on training older people, will be of interest to those concerned with problems of re-training as new mechanical and automatic processes lead to a redeployment of labour; the authors of this article were members of the Nuffield Unit for Research into Problems of Ageing. The other, by Dr. Isabel Blain, advocates systematic study of the process of learning a job. The article gives an example from the textile industry where learners were able, under suitable control, to use machines on production work at the end of their first day's training.

Other articles discuss the prediction of trainees' capacity for proficiency at keyboard work and the personality characteristics desirable in industrial executives.

New Pension Plan for Engineers

A NEW form of group insurance scheme, specially devised to meet the needs of all professional engineers, has been launched by the Engineers' Guild, the association for chartered civil, mechanical, and electrical engineers. At a Press conference in London, the Chairman of the General Council of the Guild, Mr. E. W. Greensmith, said engineers should be able to move from one big operation to another even though this involved working for different firms or as an independent consultant. The prospect of a pension under existing schemes could be a hindrance, in that it could deter men from striking out into new fields to widen their experience and to gain opportunities for using their abilities to the full. There was, too, a problem from the employer's point of view, in that he might wish to engage an experienced professional engineer, but finds it difficult because of age to fit him into an existing group pension scheme. The scheme the Guild was launching would solve most if not all of these problems.

Advantages of the scheme are that it ensures that the professional engineer can secure a continuous pension scheme and insurance cover throughout his career whatever changes take place in his employment; it operates on a group basis resulting in rates of premium and annuity rates for pensions being lower than could be secured by an individual applying to an insurance company; it permits the employer to pay some or all of the contributions if desired; medical evidence about health will not be required for the first £2,000 insured; income tax relief can be secured in respect of all premiums paid under the scheme; and the age at which a pension becomes payable can, within certain limits, be selected.

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Highest prices paid for Spent Oxide.

Send your enquiries to

GAS PURIFICATION LIMITED

PALMERSTON HOUSE, BISHOPSGATE, LONDON, E.C.2.

Telegrams: "Purification, Stock, London." Telephone: London Wall 7938/9 & 7930

FIRE!

WHERE'S YOUR

NU-SWIFT?

Details, please, of Nu-Swift rapid and reliable Fire Extinguishers—BEFORE IT IS TOO LATE!

Name.....

Address.....

Post NOW to Nu-Swift Ltd., Elland, Yorkshire

In Every Ship of the Royal Navy

"KLEENOFF" ★

THE COOKER CLEANER

"KLEENOFF"

FIBRE BRUSHES
RUBBER MOPS

"KAY-DEE" ★

KETTLE DESCALER

For resale to the public and in bulk for works use

BALE & CHURCH, LTD.

CRONPTON WAY, CRAWLEY, SUSSEX

MISCELLANEOUS

WE are interested in surplus stocks of pipe fittings, boiler tubes and condenser tubes. Please send full details. Apply No. 301, *Gas Journal*, 11, Bolt Court, Fleet Street, London, E.C.4.

PATENTS

KINGS PATENT AGENCY, LTD.
(Director, B. T. King, A.I.M.E., Patent Agent) Advice, Handbook, and Consultations free. 146a, Queen Victoria Street, London, E.C.4. 'Phone: City 6161.

PLANT FOR SALE

FOR SALE: 30' × 8' 6" dia. Pressure Vessels (ex Lancashire Boilers ceased working at 150 lbs. W.P.). Cleckheaton Engineering Co., Ltd., Cleckheaton. 'Phone 397.

FOR SALE: Unused "AUDCO" Lubricated Valves. 9—8" fig. K.G. 33; 17—6" L.W. 23; 2—6" fig. M.G.21F.; 9—4" M.W. 21F; 19—2" fig. 2,400 (Sulphate Resistant); 16—4" fig. M.W.11; 13—1" M.W. 12 (screwed); 15—6" A.3W. 3 way; 6—3" M.T.11; 6—4" MU.11F. 4 way; 11—3" M.L.11. Cleckheaton Engineering Co., Ltd., Cleckheaton. 'Phone 397.

APPOINTMENTS VACANT

SENIOR DRAUGHTSMEN with sound mechanical training required by Dust Control Engineers and Fan Manufacturers. Experience of this type of work is not necessary, but good general training and experience in plate work is desirable. Higher National Certificate desirable. Opportunity also exists for suitable applicants to train as Dust Control Engineers. Write AIR CONTROL INSTALLATIONS LTD., Victoria Road, Ruislip, Middlesex.

WEST MIDLANDS GAS BOARD

SHROPSHIRE DIVISION
MAIN AND SERVICE LAYER

A COMPETENT MAIN AND SERVICE LAYER is required by the Wellington District. N.J.I.C. Prov. 'A' rate will apply at present 4s. 0½d. per hour.

A modern house is available at a reasonable rental on a service tenancy agreement if required.

Applications, stating age and experience, should be addressed to the Manager, Gas Offices, Market Street, Wellington, to reach him not later than December 21, 1956.

WEST MIDLANDS GAS BOARD

WOLVERHAMPTON & DISTRICT DIVISION
APPOINTMENT OF SALES REPRESENTATIVE

THE successful candidate will be required to attend to consumers' enquiries, prepare estimates and develop sales. A knowledge of domestic appliances, gasfitting and consumer service is necessary and selling experience will be an advantage. The successful candidates will be sent on a comprehensive training course.

The salary for the post will be within A.P.T. Grade 6 of the National Salary Scales. (£610-£690 p.a.)

The post is pensionable and the successful candidate may be required to pass a medical examination.

Applications stating age, qualifications and experience, together with the names of two referees, should be addressed to Mr. Stanley Jones, Divisional General Manager, West Midlands Gas Board, Kensington House, Bath Street, Dudley, to reach him not later than December 19, 1956.

J. C. INGRAM,
Secretary to the Board.

WEST MIDLANDS GAS BOARD

NORTH STAFFORDSHIRE DIVISION
VACANCY FOR
ASSISTANT ENGINEER AND MANAGER
NEWCASTLE UNDER LYME DISTRICT

APPLICATIONS are invited for above position from candidates suitably qualified and who are Corporate Members of the Institution of Gas Engineers, and fully experienced in the administration and technical supervision of a medium-sized undertaking. It is essential that applicants should have sound knowledge of modern distribution practice.

The salary will be within A.P.T. Grade 11 of the National Salary Scales for Gas Staffs—£850-£975 per annum.

The post is pensionable and the successful candidate will be required to pass a medical examination.

Applications stating age, qualifications and experience, should be addressed to Mr. J. E. Stanier, Divisional General Manager, West Midlands Gas Board, Etruscan Street, Stoke-on-Trent, to reach him not later than December 19, 1956.

J. C. INGRAM,
Secretary to the Board.

NORTH THAMES GAS BOARD

SENIOR DRAUGHTSMEN are required in the Chief Engineer's Department at Westminster, S.W.1, for:—

(1) The design and layout of general process plant and all associated structural steelwork.
(2) The design and detailing of Civil Engineering, Foundations and Structural work mainly in reinforced concrete associated with Gas Manufacturing plant.

Candidates should preferably be Corporate Members of the Institutions of Civil, Structural or Mechanical Engineers.

Starting salaries within the range £850-£1,000 per annum according to age, qualifications and experience.

The successful candidates will be required to join the Staff Pension Scheme.

Applications, giving age and full particulars, should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference 666/314.

(*Classified advertisements continued on page* 674)

APPOINTMENTS VACANT (ctd.)

GAS ENGINEER DRAUGHTSMAN. Spare-time services required by small London company for designing and technical advice. Good fees offered. Apply: No. 302, *Gas Journal*, 11, Bolt Court, Fleet Street, London, E.C.4.

NORTH WESTERN GAS BOARD

MID-CHESHIRE GROUP
TECHNICAL ASSISTANT (PRODUCTION)—RUNCORN WORKS

APPLICATIONS are invited for the above pensionable appointment at a salary within Grade A.P.T. 5 (£575/£655 p.a.) according to experience.

Applicants should have had experience in the operation of gasworks plant and be capable of carrying out routine chemical tests.

Detailed applications should reach the General Manager, N.W.G.B., Mid-Cheshire Group, Hartford Manor, Greenbank, Northwich, Cheshire, within 14 days.

EASTERN GAS BOARD

WATFORD DIVISION
DISTRIBUTION FOREMAN—WELWYN GARDEN CITY

APPLICATIONS are invited for the position of DISTRIBUTION FOREMAN, Welwyn Garden City and Hatfield. The successful applicant will be responsible to the Distribution Superintendent, St. Albans, and he should have a wide experience in all aspects of Low Pressure and High Pressure mains and service work, also control of labour.

The salary will be within Intermediate Grade VI (£570-£615). Conditions II, and housing accommodation can be obtained with the Welwyn Garden City and Hatfield Development Corporation for applicants from the London Area.

Applications should be addressed to the undersigned not later than January 1, 1957.

SERVICELAYER—HARPENDEN

A **FIRST CLASS SERVICELAYER is required at** Harpenden. The rate will be in accordance with J.I.C. (Fringe Met.) 4s. 1½d. per hour and facilities are available for advancement to Special Servicelayer (by examination) at 4s. 4½d. per hour.

A house situated at Harpenden is available at a reasonable rent.

Applications should be addressed to the undersigned not later than January 1, 1957.

W. A. EVETTS,
Divisional Engineer.

Eastern Gas Board—Watford Division,
Radiant House,
Clarendon Road,
Watford, Herts.

WALES GAS BOARD

SALES AND SHOWROOM MANAGER—RHYL UNDERTAKING

APPLICATIONS are invited for the above Appointment.

Candidates should be fully experienced in all aspects of Domestic and Commercial Gas Sales, including Showroom Management, Publicity, Sales Campaigns, District Canvassing, Home Service Work and dealing with consumer complaints. The person appointed will be required to maintain close liaison with Local Authorities, Architects and Builders in the area. Possession of the I.G.E. Certificate in Gas Salesmanship and Consumer Service (or equivalent qualification) will be an advantage.

The salary for the post will be in accordance with Grade A.P.T. 5 (Provincial 'A') (£575/£655) of the National Salary Scale for Gas Staffs, with placing according to experience and qualifications. The post is pensionable.

The successful applicant may be required to pass a medical examination.

Applications, stating age, particulars of training, qualifications and experience, together with the names of two referees, should be addressed to the undersigned not later than Monday, January 7, 1957.

O. P. CRONSHAW,
Engineer and Manager.

Gas Offices,
93, Wellington Road,
Rhyl.

DEMONSTRATOR/HOME SERVICE ADVISOR

R. & A. MAIN, LTD., Domestic Appliance Manufacturers, require the services of a first class DEMONSTRATOR. Minimum age 25. The post offered is permanent and will involve travelling.

Applicants must have qualifications in domestic science, be accustomed to demonstrating before large audiences, and possess personality and tact. An attractive salary will be paid to the successful applicant.

Applications giving full details as to age, experience qualifications and present salary should be addressed to the Personnel Manager, R. & A. Main, Ltd., Gothic Works, Angel Road, Edmonton, N.18.

SOUTHERN GAS BOARD

SUPERVISOR (FEMALE)—PUNCH-CARD DEPARTMENT

APPLICATIONS are invited for the post of SUPERVISOR, Punch-card Department, on the staff of the Chief Accountant at Area Headquarters, Southampton. The starting salary will be not less than £802 per annum, within Grade A.P.T.II of the National Salary Scales for Gas Staffs.

Applicants must be thoroughly experienced in punch-card systems and must be capable of organising and efficiently supervising the department.

The successful candidate may be required to pass a medical examination, and, unless already subject to a Pension Scheme by virtue of the Gas (Pension Rights) Regulations, 1950, will be required to join the Board's Staff Pension Scheme.

Applications, stating age and education, and giving full details of experience together with the names of two referees, should be addressed to reach the undersigned not later than December 22, 1956.

P. VALON BENNETT,
Personnel Manager.

164, Above Bar,
Southampton.

Amended Advertisement

KARACHI GAS COMPANY
PAKISTAN

INSTRUMENT FITTER

THE above Company, which distributes natural gas in the Federal Area of Karachi, requires an INSTRUMENT FITTER.

The successful candidate will be responsible for the operation and maintenance of all types of pressure regulation and flow measurement equipment and instruments used in the gas distribution system. A general background of gas distribution practice will be of advantage.

The appointment will be on the basis of an initial three year contract and the nett salary, after deduction of tax, will be of the order of Rs. 1,850 per month (approximately £1,675 p.a.). Free accommodation will be provided, which, after a qualifying period, will include for family.

Applications stating age, qualifications, experience and the names of two referees should be addressed to the Personnel Manager, D. & C. and William Press, Ltd., Twenty Albert Embankment, London, S.E.11, to arrive within two weeks of the appearance of this advertisement.

SCOTTISH GAS BOARD

PRINCIPAL HOME SERVICE ADVISER

APPLICATIONS are invited, from persons of proved administrative and organising ability holding a recognised domestic science diploma or equivalent qualification, for the post of PRINCIPAL HOME SERVICE ADVISER at Board Headquarters, Edinburgh.

As the post is pensionable, the successful applicant will be required to pass a medical examination, and will be responsible to the Commercial Manager for conducting the Board's Home Service activities.

The salary payable will be in accordance with Grade A.P.T. 10, and initial placing will be related to qualifications and experience within the range £700-£784 per annum. The maximum salary will reach £920 per annum by 1961.

Applications, stating age and giving details of education, qualifications and experience together with the names of two referees, should be addressed to the undersigned for receipt not later than 14 days after the appearance of this advertisement.

A. T. HERD,
Secretary.

26, Drumsheugh Gardens,
Edinburgh, 3.

SCOTTISH GAS BOARD

SOUTH EAST DIVISION
DENNY DISTRICT

APPLICATIONS are invited for the positi TECHNICAL ASSISTANT. Candidates should have a sound knowledge of the operation of Vertical Retorts and usual gasworks ancillary plant, and must be capable of carrying out all normal tests.

The salary for the appointment will be within Grades 3/5 (Provincial 'A') of the National Scales for Gas Staffs, with placing according to experience and qualifications. A house can be made available at a reasonable rent.

The post is pensionable, and the successful applicant will be required to pass a medical examination.

Applications stating age, and giving full details of education, training, experience and any qualifications, should be addressed to the Manager, Denny District, to arrive not later than December 31, 1956.

Gas Engineer's Office,
Denny,
Stirlingshire.

A VACANCY occurs in the Design & Development Laboratory of W. H. Dean & Son, Ltd., makers of domestic gas appliances, for a LABORATORY ASSISTANT.

Applications from suitably qualified persons, giving full details of experience, etc., should be made to the Design and Development Engineer, Victoria Works, Burnley, Lancs.

NOW READY

KING'S MANUAL OF GAS MANUFACTURE

SECTION 7a

Gas Cooling and Tar Fog Removal

by

Charles Cooper, M.Sc., M.Inst.Gas.E., M.I.Chem.E., and James J. Priestley, M.Sc., M.Inst.Gas.E., A.M.I.Chem.E. (W. C. Holmes & Co., Ltd.)

PRICE

Inc. **15/-** *postage*

WALTER KING, LTD.
11 BOLT COURT
FLEET STREET · LONDON, E.C.4

COMPRESSORS & EXHAUSTERS FOR AIR AND GAS.

See our Advertisement Next Week.

REAVELL & CO. LTD. IPSWICH.

CASES FOR BINDING

Quarterly Volumes of the 'Gas Journal'

7/6 each, post free

Walter King, Ltd., 11, Bolt Court, Fleet Street, London, E.C.4

Specify

HOLMES-WESTERN

Valves

55 PATTERN

The Holmes-Western Valve is of the double disc parallel slide type and has been specifically designed for the Gas and Coking Industries.

British Patent No. 758253.

The illustration shows a 12" motorized Holmes-Western Valve.

Write for copy of Publication No. 52/S

W. C. HOLMES & CO. LTD

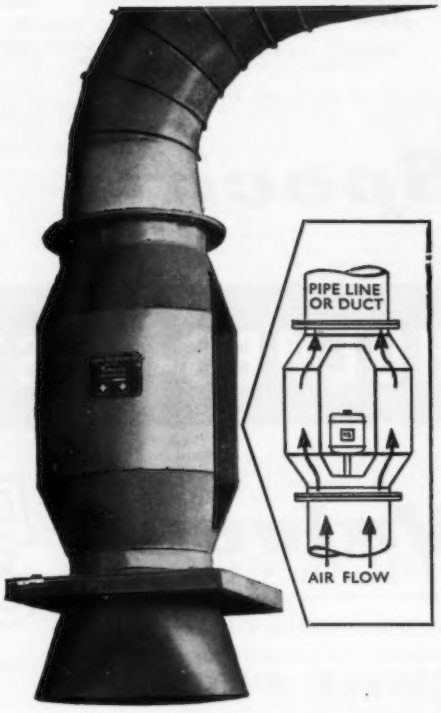
HUDDERSFIELD · LONDON · BIRMINGHAM

Huddersfield 5280 London: Victoria 9971 Birmingham: Midland 6830

the reasons why Bifurcated Fans are used for extracting Fumes and Gases

from FUME CUPBOARDS · DE-GREASING, DE-SCALING and DE-OXYDISATION BATHS · PICKLING and NEUTRALISING TANKS IMPREGNATING TANKS · PAINT SPRAY BOOTHS FURNACES and FORGE PRESSES · CONFECTIONERY and BAKING OVENS

BECAUSE within the operational range of these units no other fan compares for price, design simplicity and economy of space. Bifurcated fans are direct driven units which will handle obnoxious fumes and gases up to 350° F. Their easily accessible K.B. made, totally enclosed and weatherproof motors are completely isolated from the fumes or gases handled.
Ranging up to 25″ diameter, the sizes are matched to commonly used pipes and ducts. 10″, 12″, 14″, 16″ and 19″ fans are held in stock. If you want full details of this exclusive fan type write now for Publication No. 28/7



Keith Blackman Ltd
MILL MEAD ROAD, LONDON, N.17
Fan Makers to the Chemical Industry

T.A.7164/605

WATERPROOF FIRST AID

Waterproof First Aid Dressings are intended for use when a wound is exposed to water, or contamination from oil, dirt etc., and also where necessitated by hygienic requirements.
Illustrated is our most popular assortment of such dressings (Adaptopruf No. M207) consisting of 114 adhesive plasters of five different sizes. Each has a dressing pad of soothing, quick healing Euflavine, a most effective medicament equally for wounds *and* burns.
Whenever a waterproof plaster is not essential we recommend Adapto*plast* First Aid Dressings be used.

PIONEERS OF INDUSTRIAL FIRST AID | A PRODUCT OF Curson, Gerrard & Co. Ltd. OLDBURY BIRMINGHAM | ESTABLISHED 1878 'Phone BROadwell 1355

SUPER PIPE JOINT COMPOUND by "SCOLS"

A superior JOINTING COMPOUND that is consistent in quality, being manufactured to rigid specification. The high-grade ingredients, including genuine Boiled Linseed Oil, combine to produce a product that is unaffected by extremes of temperature, sea-water, and industrial atmospheres. The ideal JOINTING COMPOUND for steam, gas, water or air piping. Joints can be broken without damage to threads fittings.

"SCOLS" Super Pipe Jointing Compound is available in three forms—
Graphite White Asbestos

MAJOR, ROBINSON & CO. LTD.
SCOLS WORKS WARWICK RD. SOUTH
MANCHESTER 16. ENGLAND

Registered as a Newspaper. Printed by STRAKER BROTHERS LTD., E.C.2 for WALTER KING LIMITED, 11, BOLT COURT, FLEET ST., LONDON, E.C.4., Wednesday, December 12, 19

A NEW FACTOR IN COKE GRADING

FLÄMRICH RESONANCE SCREENS

High screening capacity per sq. ft

Freedom from vibration in supporting structure

Low headroom

Low power requirement

Gentle treatment of material

Designed and manufactured in the U.K. by :—

WEST'S

WEST'S GAS IMPROVEMENT COMPANY LIMITED
Albion Ironworks, Miles Platting, Manchester, 10
Telephone : COLlyhurst 2961. Telegrams : Stoker, Manchester

LONDON : COLUMBIA HOUSE, ALDWYCH, W.C.2. Tel.: HOLborn 4108
C.O.L. DIV.: CHANDOS HOUSE, BUCKINGHAM GATE, S.W.1. Tel.: ABBey 6912

F1

GAS Commercial Appliances

The RED-RAY GRILLER

Something NEW in the RESTAURANT, SERVICE BAR and GRILL-ROOM

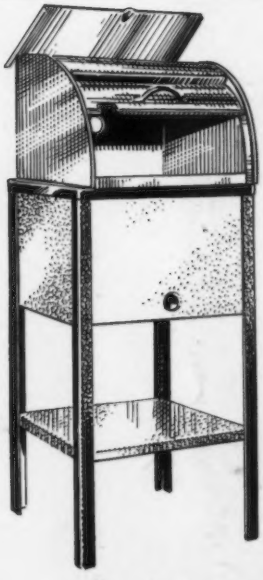
3 POSITIONS of BURNERS

① For GRILLS

② For SPIT ROASTING
A stainless Steel Spit complete with Basting Tray can be fitted as an Optional Accessory.

③ For MIXED GRILLS
SAUSAGES, TOMATOES ETC.

The penetrating Infra-Red Rays cook steaks and chops to perfection in 3½ minutes at a cost of less than one half-penny.
The 'COLWIN' RED-RAY GRILLER is finished in White and Grey Mottled Vitreous Enamel with plated Anti-Corrosive easily cleaned fittings.
DIMENSIONS: Height 16¾" Width 18½" Depth 17¾" Weight 57 lb.

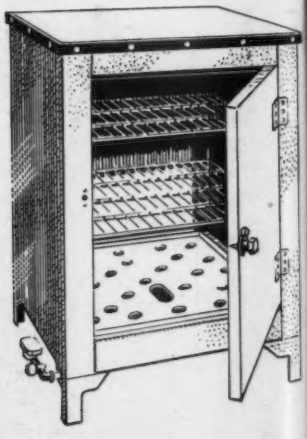


'COLWIN 1'
CHIP AND FISH RANGE

A compact range with a Pan 13" × 13" × 7" in dimension to supply small quantities of chipped potatoes at short notice.

The 'COLWIN'
HOT CUPBOARD

An inexpensive warming oven for use where it is necessary to keep hot, dishes, plates and meals. Right or left hand, or double doors.
DIMENSIONS 2' 11" high 2' 0" deep 2' 0" wide



Leaflets and Technical Details on request

Metropolitan GAS METERS LTD.
FOREST ST., HYSON GREEN, NOTTINGHAM
Telephone: NOTTM. 74616-7 Telegrams: GASOMETER, Nottm.
Branches at LONDON, LEICESTER and COLWYN BAY